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TITLE: Development of an Integrated Team Training Design and Assessment Architecture to Support Adaptability in Healthcare Teams

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13. SUPPLEMENTARY NOTES

14. ABSTRACT

Purpose and Scope: It is the purpose of this project to optimize adaptability and mitigate teamwork-related threats to patient safety by addressing key methodological and conceptual gaps in healthcare simulation-based team training. The investigators are developing the necessary conceptual framework and team performance assessment mechanisms to support training systems that improve adaptability and performance in trauma teams.

Aim 1a. Develop a team training design architecture to support simulation-based training/assessment systems capable of developing adaptive expertise in healthcare teams

Aim 1b. Develop evidence-based guidelines and recommendations for the development of embedded, adaptive feedback and performance assessments

Aim 2. Develop and refine a predictive model of trauma team performance and outcomes for use in an adaptive guidance system

Major Findings: The investigators performed a four-step process to develop a unified team training design architecture and supporting conceptual framework. They identified key training design principles and recommendations for the development and implementation of embedded, adaptive feedback and performance assessment. The investigators designed a prototype of a Bayesian Belief Network (BBN)-based model of trauma team performance and outcomes. The investigators went through several model iterations and settled on one model for final testing. This testing and validation (Aim 2) is the focus of the NCE year.

Impact: The provision of emergency care in a combat situation mandates well-developed adaptive expertise, making this work relevant to military healthcare. Our work provides a roadmap and mechanism for future work in a multitude of healthcare teams and settings.

15. SUBJECT TERMS					
Military healthcare team; Trauma teams; Team training; Teamwork; Adaptive performance; Leadership; Simulation; Modeling; Bayesian belief networks (BBN)					
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Table of Contents

1. INTRODUCTION

Health care team performance is critical to the provision of safe, efficient, and effective care. Team adaptability is necessary for effective team performance and is especially critical for trauma teams, whose members must anticipate change and rapidly coordinate effective responses. Teams that are not highly adaptive function in a reactive mode that is fraught with potential safety and error risks. Rigorously designed computer-based simulation systems have the potential to support active learning experiences and improve adaptability and performance in individuals and teams. This technology has the potential to link individuals, teams, and units together for the purpose of engaging in common training exercises. However, without the proper supporting design elements, these simulations are ineffective and inefficient training tools. Current health care team training models and strategies do not specifically leverage the training design elements and assessment-driven feedback mechanisms that improve team performance in highly dynamic settings. The **goal of the proposed project is to improve health care team adaptability and patient safety** by providing the necessary conceptual framework and assessment mechanism to support the design and implementation of highly effective simulation-based team training with embedded, adaptive guidance. This project is organized into the following Aims:

Aim 1a. Develop a team training design architecture to support simulation-based training /assessment systems capable of developing adaptive expertise in healthcare teams

Aim 1b. Develop evidence-based guidelines and recommendations for the development of embedded, adaptive feedback and performance assessments

Aim 2. Develop and refine a predictive model of trauma team performance and outcomes for use in an adaptive guidance/feedback system

The **outcomes** from this research will provide the fundamental knowledge, both conceptual and operational, to support the development of simulation-based team training systems with embedded guidance. Our **long-term goal** is to optimize health care team performance and adaptability through rigorous training design.

2. KEYWORDS AND ABBREVIATIONS

Healthcare team
Trauma
Trauma teams
Team training
Teamwork
Adaptability
Adaptive performance
Leadership
Simulation
Modeling
Bayesian belief networks (BBN)

3. ACCOMPLISHMENTS

3a. What were the major goals of the project (organized by Aim)?

Aim 1a. Develop a team training design architecture to support simulation-based training/assessment systems capable of developing adaptive expertise in health care teams

Aim 1b. Develop evidence-based guidelines and recommendations for the development of embedded, adaptive feedback and performance assessments

The primary outcome of Aim 1a is a conceptually and methodologically sound training design architecture that supports the development and integration of team training and automated assessment technologies in simulation environments. The primary outcome of Aim 1b is a set of best practice guidelines and recommendations for the design and incorporation of adaptive, embedded feedback (guidance) into simulation-based team training. The tasks, timeline, and status of each step associated with Aims 1a and 1b are summarized in the table below.

This Aim is 100% completed, with manuscript preparation and dissemination underway. We will revisit and update concepts and principles based upon information gained in Aim 2. The work proposed is complete.

Aims 1a and 1b: Major Goals and Tasks

Aims 1a and 1b Tasks	Timeline (Months)	Status
Task 1: Project Start-up		
Establish subcontracts to enable purchasing.	0 – 3	**Completed**
Local/Site IRB application submissions	0 – 3	All IRB submissions have been completed and the project has been awarded exempt status by each institution. **Completed**
Assembly of subject matter expert panel	0 – 3	Subject matter experts have been invited and the panel now contains experts from emergency medicine, simulation, trauma surgery, and nursing. Individuals were chosen for their expertise and to ensure geographical representation. **Completed**
Human Research Protection Office IRB	3	The HRPO has granted exempt status. **Completed**
Milestone(s) Achieved: 1. Project infrastructure in place 2. Local/Site IRB and HRPO Approval	6	**100% COMPLETED**
Task 2: Identify constructs of interest		
Literature search strategy	0 – 3	Search strategy within healthcare literature, trauma performance literature, trauma outcomes literature, and team science has been defined. **Completed**
Review of identified manuscripts and literature	0 – 6	The review of relevant literature (healthcare and team science) to inform the conceptual model and framework of adaptive performance has been completed. **Completed**
Milestone(s) Achieved: 1. Identification of individual and team performance constructs for the conceptual framework and training architecture	6	We identified relevant individual and team constructs and designed a draft framework. We anticipate continuing to revisit this framework as model testing occurs (Aim 2). We show this as an ongoing milestone nearly complete. **ON TIME, 99% COMPLETED**
Task 3: Determine relevant variables and relationships		
Develop nomological net among constructs identified in Task 2	3 – 9	We have identified key relationships between processes and variables critical for team adaptability. **Completed**
Subject matter expert review of variables and relationships	6 – 9	Trauma care and military experts reviewed the components of our adaptability model. Modifications included the addition of cognitive adaptability and diagnostic process as a key component of trauma team adaptive capacity. **Completed**
Milestone(s) Achieved: 1. Identification of relationships between individual and team performance constructs for the conceptual framework and training architecture	9	**99% COMPLETED** We indicate this milestone as near completed as we intend to use relevant data from Aim 2 to refine our work

Task 4: Identify appropriate level of constructs and variables		
Identification of appropriate levels for constructs, relationships, and outcomes identified in Task 3	6 – 9	Literature reviews and subject matter expert opinion was used to choose and adapt a model of individual, team, and system-level measurement necessary to guide the development and implementation of effective team training. **Completed**
Milestone(s) Achieved: 1. Multilevel framework of healthcare team training performance	9	We identified relevant individual and team constructs and designed a draft framework. We anticipate continuing to revisit this framework as model testing occurs; therefore will reflect this as an ongoing milestone nearly complete. **ON TIME, 99% COMPLETED**
Task 5: Identify appropriate outcome measures and mechanisms		
Construct framework for provision of adaptive guidance during simulation-based team training	6 – 9	Relevant feedback mechanisms and designs have been identified and a draft framework has been designed. We anticipate revising the feedback mechanisms and design based upon Aim 2. We therefore reflect this task as **On time, 99% completed.**
Subject matter expert review of feedback framework	9 – 12	Our military, external team science, and external emergency medicine subject matter experts reviewed the structure of our feedback framework to ensure the framework is compatible with current military training efforts and reflective of current team science recommendations. **Completed**
Milestone(s) Achieved: 1. Integrated team training design architecture 2. Evidence-based guidelines and recommendations for the provision of embedded, adaptive guidance	12	As noted we will revisit recommendations and principles based upon findings in Aim 2. We therefore reflect this milestone as **99% COMPLETED** See Attachments 1 – 3, remainder of material was provided in the 2016 annual report.
Task 5a: Cross reference feedback principles and team training architecture with TeamSTEPPS terminology (ADDITIONAL TASK ADDED TO ADDRESS IPR)		
Review current terminology and link both feedback principles and training architecture with TeamSTEPPS principles and trainer materials	18	This work was not initially proposed but was added in response to the IPR comments. We completed this work and provide these materials in Attachments 1 – 3. **Completed**
Review current terminology and ensure Crawl-Walk-Run terminology is incorporated and clearly highlighted for instructors.	18	This work was not initially proposed but was added in response to the IPR comments. We completed this work and provide these materials in Attachments 1 – 3. **Completed**
Milestone(s) Achieved: 1. Developed a glossary of terms linking feedback guidelines and training architecture with TeamSTEPPS components.	18	Please see Attachments 1-3, we now note where TeamSTEPPS concepts fit within our framework. **100% COMPLETED**

Aim 2. Develop and refine a predictive model of trauma team performance and outcomes for use in an adaptive guidance/feedback system

The primary outcome from Aim 2 is a predictive trauma team performance assessment tool that generalizes to teams of varying expertise levels and across civilian and military contexts and is capable of supporting embedded, adaptive guidance during simulation-based team training. Our approach examines the use of Bayesian Belief Networks (BBNs) to support the provision of adaptive, embedded guidance that facilitates development of adaptive expertise and trauma team performance. We utilize existing simulation-based trauma team performance data to construct a BBN that models the relationships between key individual and team characteristics, behavioral outcomes, and patient care events in a previously well-defined and validated simulated scenario. The model will leverage the probabilistic interdependencies among these variables to enable educators and/or learners to assess the likelihood of critical team/patient outcomes in the simulated environment. We then incorporate the design architecture conceptual foundations developed in Aims 1a&b to guide the transformation of predictive model data into an adaptive guidance tool. The tasks, timeline, and status of each step associated with Aim 2 are summarized in the table below.

Aim 2: Major Goals and Tasks

SPECIFIC AIM 2	Timeline (Months)	Status
Task 6: Collection of prospective simulation data		
Subject recruitment	4 – 6	**Completed, 100% completed**
Execute trauma resuscitation simulations	4 – 6	We have completed the simulations necessary for the study; however, we wish to maximize the inclusion of military personnel and therefore will continue to enroll military providers through September 2017. This will extend enrollment and is one reason we are requesting a NCE. No additional funds will be required to complete this work. **95% completed**
Train and calibrate raters	6	Rater training has been designed to code new simulations. Existing trauma videos have been coded, with excellent inter-rater reliability. We anticipate refresher training periodically. **Ongoing, Initial work 100% completed.**
Code videos of simulated resuscitations using patient care and teamwork measures	6 – 12	Simulation video processing has slightly delayed the initiation of coding; coding is now underway. To ensure timely completion, we have hired additional video processors and purchased additional storage to allow more rapid, efficient video processing. With continued enrollment of military providers, this work will continue until all simulations are completed. This will extend into the NCE period. **Delayed, 90% complete**
Transform data into appropriate categorical structure for BBN	9 – 12	We completed initial transformation of existing data into a categorical structure. This is required to execute BBN modeling and requires the input of clinical experts. Based on this data transformation, an initial structure for the BBN was constructed using the transformed data (see also Task 8). Choices about data discretization and model structure offer different advantages that the research team continually evaluates, so we anticipate this process being an iterative one as we proceed through Tasks 7 and 8. A second version of the BBN has been developed based on behavioral clusters identified from existing simulation-based resuscitation performance data. This prototype BBN has been entered into the Netica software for further analysis. Overall, this subtask is part of an iterative process with refinement of the model occurring throughout Aim 2. We therefore reflect this step as **99% Completed**

Milestone(s) Achieved: 1. Team data set of teamwork and patient care performance during trauma resuscitation simulation	12	**In Progress, 90% COMPLETE** (This work is ongoing, as refining the model based on new results is part of the development process)
Task 7: Identify and define variables (nodes) for inclusion in team assessment model		
Examination of conceptual frameworks and literature review from Aims 1a and 1b	9 – 12	We have finalized the review of feedback principles to make final decisions regarding when the BBN will be designed to provide information to learners and instructors and in what format the feedback should be delivered. This subtask was delayed by approximately 1 month and is now completed. **Completed**
Evaluation of existing experimental dataset to identify and extract variables of interest	9 – 12	We have completed review of all existing datasets. This process resulted in identification of ~150 usable variables for which data is available. We developed protocols for evaluating inclusion/selection of items as variables in the BBN. An initial protocol was used to guide the development of the first prototype BBN (see also Tasks 6, 8), and an additional protocol has been developed to guide the development of a second version of the BBN. This task is on time and completed for the initial BBN and revised BBN. Prior to final dissemination this step will be revisited; however, the proposed work is completed. We therefore reflect this as **99% Completed**
Milestone(s) Achieved: 1. Identification of observable measures and latent constructs to be incorporated into the BBN	12	**99% COMPLETED** (This milestone is largely completed, delays reflect extended subject enrollment and the iterative process of BBN development)
Task 8: Design the structure for the prototype BBN team assessment system		
Identify appropriate and parsimonious candidates for the causal structure among the variables	12 – 15	We have developed and evaluated multiple possible organizational structures for BBNs. We provided an initial draft of these in the annual report submitted 11/2016 and an updated draft on 06/30/2017. The research team since identified and evaluated three alternative structures of the BBN based on utility of application. The most recent BBN structure (described further below) has been applied to model all events during a trauma simulation. Relationships represented in the BBN will likely be iterated as the remainder of the simulation is modeled, but the foundational work is completed. **99% completed, (work is iterative)**
Subject matter expert review of variable relationships	12 – 15	To facilitate a thorough and comprehensive SME review, including military experts, the research team decided to hold the review after the final prototype of the model is completed. As a result, this subtask will be accomplished during Q9 as part of finalizing the prototype prior to testing. **0% completed, (Q9 completion planned)**
Milestone(s) Achieved: 1. Identification of multiple candidate BBNs for the observed variables	15	**DELAYED, 80% COMPLETED (Q9 completion planned)**
Task 9: Generate initial probability tables for BBN team assessment system		
Transform data into appropriate categorical structure	12 – 15	Based on the proposed BBN structure developed in Task 8, we transformed the dataset into categorical structures that logically developed based upon the clinical content and the BBN prototype structure. Choices about how to discretize certain data and/or whether existing simulations should be recoded to facilitate the model completion will be evaluated as the final BBN prototype is completed. This work is completed, but will be revisted after testing the BBN with the existing dataset. **99% COMPLETED**

Explore different learning algorithms	15 – 18	This work will begin in earnest using the revised version of the BBN. The initial version was a prototype and did not contain the structural data elements necessary for testing. We anticipate that this work will be completed in the first quarter of the NCE year. **Delayed, 0% completed**
Assess BBN fit	15 – 18	This work will begin in earnest using the revised version of the BBN. The initial version was a prototype and did not contain the structural data elements necessary for testing. We anticipate that this work will be completed in the first quarter of the NCE year. **Delayed, 0% completed**
Generate conditional dependencies for unavailable data	15 – 18	This work will begin in earnest using the revised version of the BBN. The initial version was a prototype and did not contain the structural data elements necessary for testing. We anticipate that this work will be completed in the first quarter of the NCE year. **Delayed, 0% completed**
(NEW SUBTASK) Recode existing videos to provide additional data to provide additional nodes and data for the BBN	24 – 30	This subtask was added based upon early drafts of the BBN. We identified additional items that would support the BBN development and make our process more adaptable to other trauma care events. **New Subtask, 0% completed**
Milestone(s) Achieved: 1. Functional prototype BBN team assessment system	18	**Ongoing, 30% completed**
Task 10: BBN team assessment system calibration		
Transform prospective data into appropriate categorical structure for BBN	12 – 15	This process will be performed as part of the data analysis from prospective data collection. As data coding is not complete, this work has been delayed. However, the transformations that have been performed on existing data will provide a clear roadmap for this process and we anticipate no problems with this work based upon current data transformations. This work will occur in the second quarter of the NCE year. **Delayed, 0% complete**
Use prospectively collected data to calibrate BBN	18 – 21	This work is also delayed and will follow the above subtask, will be completed in the second quarter of the NCE (PY3) year. **Delayed, 0% completed**
Use subject matter experts and empirical data from the literature review in Aim 1a to adapt the BBN as needed	18 – 21	This work will naturally follow the prospective data collection and will form the final step of the project. We anticipate this work will occur in the third quarter of the NCE year (PY3). **Delayed, 0% completed**
Milestone(s) Achieved: 1. Functional, generalizable prototype BBN trauma team assessment system	21	**Delayed, 0% completed**
Task 11: Report writing and dissemination		
Prepare final report and manuscripts	21 – 24	**Planned, 0% completed**
Submit final reports and manuscripts	24	**Planned, 0% completed**
Milestone(s) Achieved: 1. Dissemination of methodological approach and empiric findings	24	**Planned, 0% completed**

BBN = Bayesian Belief Network

3b. What was accomplished under these goals (organized by Aim)?

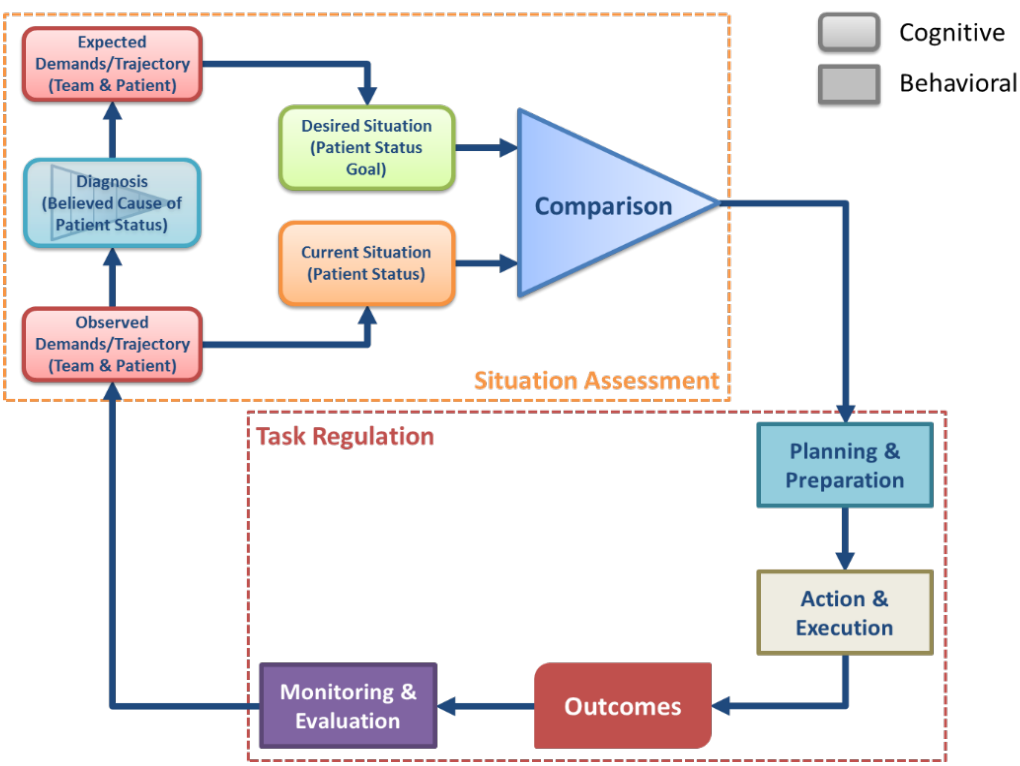
Aim 1a. Develop a team training design architecture to support simulation-based training/assessment systems capable of developing adaptive expertise in health care teams

Aim 1b. Develop evidence-based guidelines and recommendations for the development of embedded, adaptive feedback and performance assessments

Data Collection: A robust literature review is critical to the development of a comprehensive health care team training design architecture. We conducted an extensive literature review, both within healthcare and team science literature to identify key components of team performance adaptability. We focused specifically on identifying the individual and team processes that drive adaptive behaviors, as well as possible metrics that would indicate adaptability at individual and team levels. We then convened a multidisciplinary group of nurses and physicians from both civilian and military health care settings to provide expertise and insight into how these adaptive behaviors translate to the health care setting, and how they might develop over different levels of expertise. Finally, we observed both simulated and actual trauma team performance to augment our data and further our understanding of how adaptive performance unfolds during highly complex clinical activities. This information was then used to inform the identification of **key conceptual models** described below.

Defining Adaptive Performance in Trauma Teams: We used the literature review and subject matter expert review described above to identify all individual and team-performance concepts and constructs that are relevant to training, assessing, and supporting adaptive trauma team performance. Our initial adaptive performance model did not reflect the need for trauma teams to rapidly incorporate new diagnostic information into the team's plans and processes. Subject matter experts raised an issue that cognitive processes were not adequately represented. We therefore reviewed the diagnostic error literature, diagnostic decision-making literature, and team learning research to augment our model. The result is listed in Figure 1.

Figure 1.



This model reflects the cognitive and behavioral process components of trauma team performance. First, cognition is represented by the team's efforts to make sense of the situation (Situation Assessment). Briefly, the team must use existing data/observations to identify the patient- and team-related tasks and demands. This information is then used to develop a differential diagnosis. Based on this/these diagnoses, the team has

expectations regarding how the patient will respond to treatments and how his/her condition will evolve over time. The team continuously compares this “expected” state to the “observed” state of the patient. This comparison informs the team and helps regulate the team processes that regulate task performance. If the team notes a mismatch between expected patient improvement and current patient condition, this should prompt the team to review their plan, make adjustments, and execute the modified plan. The results of these new actions should be monitored and evaluated. The observations made during evaluation become the information that the team uses to reassess the situation, reconsider the differential diagnosis(es), and the adaptive cycle continues. In a rapidly evolving trauma resuscitation, this cycle repeats continuously to ensure the team is adapting to the unstable patient/team/environment.

Identifying appropriate training targets: Training should be purposeful and should target appropriate cognitive, behavioral, and affective/motivational processes in a stepwise fashion. Training mechanisms should support both skill implementation in the clinical environment as well as transfer to novel situations. We identified a staged approach to training that targets appropriate skills necessary to develop adaptive capacity. We include both individual and team-based processes as well as training mechanisms. The framework below (Figure 2) provides an outline for this approach.

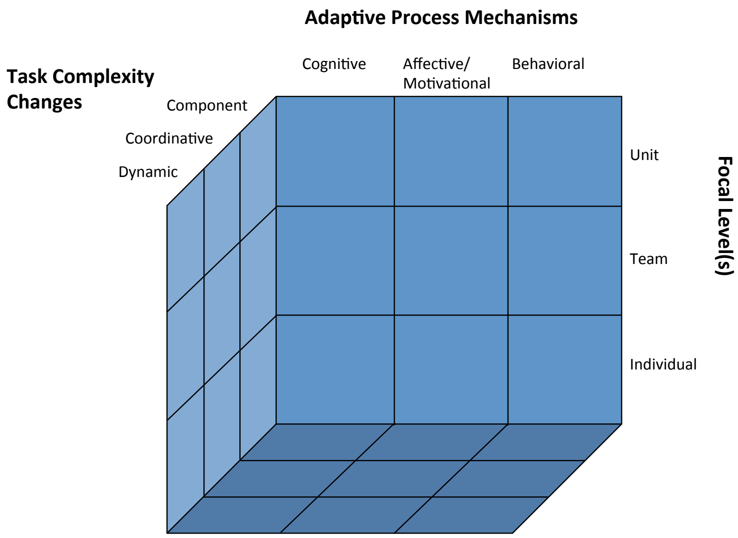
Figure 2. Training targets and training techniques

Basic **Knowledge and Skill Complexity** *Advanced* →

	Instructional Goal			
	Declarative Knowledge/Skill	**Procedural Knowledge/Skill**	**Strategic Knowledge/Skill**	**Adaptive Knowledge/ Skill**
Targeted Knowledge/Skill	Facts, concepts, rules; Definitions, meaning (*What?*)	Task principles; Rule application (*How?*)	Task contingencies; selective application (*Where, when, why?*)	Generalization of task rules, principles, contingencies (*What now, what next?*)
Exemplar Task-based KSAs	Risk factors for ACS	ACLS algorithms ATLS algorithms	Treating undifferentiated shock	Contingency planning based on patient response to treatment
Exemplar Team-based KSAs	Team processes Shared cognition Leadership functions	Communication protocol Feedback/debriefing Conflict management	Resource management Consensus-building Problem definition	Situation awareness Task regulation Affect regulation
Instructional Delivery Technique	Memorization Static practice Consistent Automaticity	←	→	Experimentation Dynamic practice Variable mapping Controlled processing

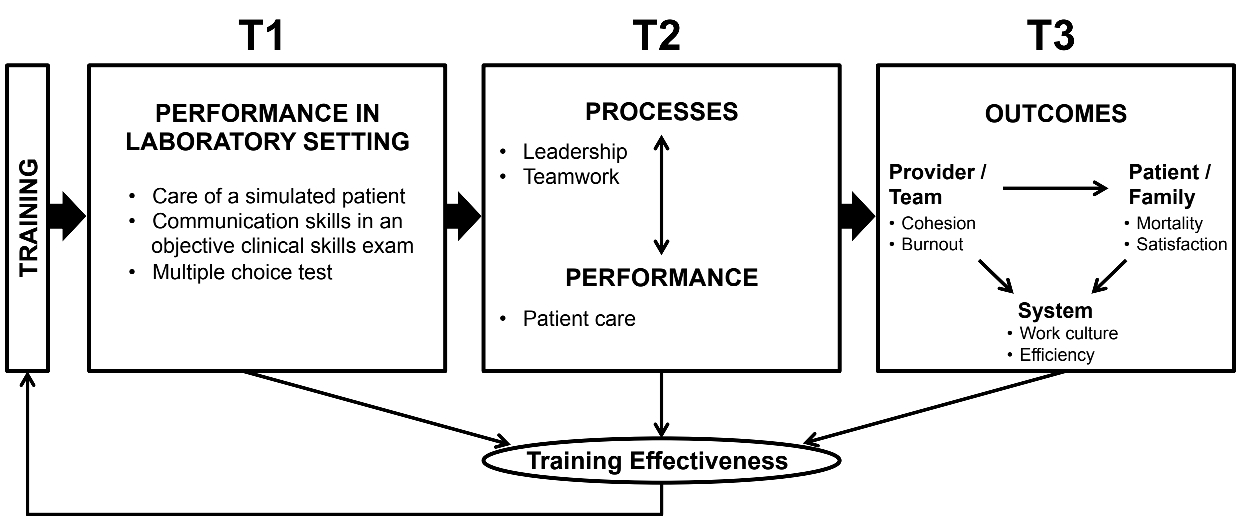
Identifying appropriate level of constructs and variables: A thorough understanding of individual and team performance within complex environments necessitates a multilevel approach to theory-building and outcomes research. Organization-level phenomena emerge through the behavior, perceptions, affect, and interactions of individuals and team. Likewise, individuals and teams are directly influenced by the culture, norms, and structure of the organization. Ignoring the multilevel nature of a construct, intervention, or relationship may result in oversimplification of outcomes and failure to recognize important measurement targets. We developed a multilevel conceptual architecture of adaptation that considers (1) the types of events teams must adapt to (i.e., what type of change is occurring), (2) the types of processes teams use to adapt, and (3) at what level these processes occur. This taxonomy (Figure 3) can help guide the selection of appropriate training targets and can help educators target correct task complexity, appropriate processes (cognitive/behavioral/affective), and direct training and measurement at the correct level (individual, team, unit). Such specificity is important, as being purposeful when designing training will ensure that individuals, teams, and units are prepared for the specific types of adaptation necessary for their work. This level of specificity in training is often overlooked and is not part of current training guidelines. In Attachment 1 we describe training principles related to (1) level of training and (2) specific processes targeted by training. In Attachment 2 we then describe three different task requirements for adaptability and specifically identify training principles associated with each type of task complexity.

Figure 3. Model of task complexity, processes, and level(s) of analysis



Identifying appropriate outcome measures and mechanisms: We noted that training evaluation systems should consider both proximal and distal outcomes. Proximal outcomes include both learning and performance-based outcomes and can include basic declarative knowledge as well as more complex strategic knowledge and performance. Distal outcomes that are trainee-focused include the transfer of learned skills to the work (clinical) environment as well as the application of learned skills to novel situations, i.e., adaptability. High-level distal outcomes include patient, system, and organization-level outcomes. Our literature review focused on the identification of pertinent proximal and distal outcomes. We considered our own systematic reviews as well as other health care team reviews to determine the current state of team assessment. We extended this knowledge by investigating the team science, safety science, and human factors literature. Because our work focuses on developing adaptive expertise, considerable efforts were made to identify outcome measures that reflect adaptive capacity. Subject matter expert review was utilized to help identify where non-health care team assessments can be translated into appropriate health care team training evaluation targets. In Figure 4 we propose a translational simulation-based research model that considers appropriate outcome measures and relationships for individual and team-level adaptability.

Figure 4. Multilevel outcome model for training evaluation



Recommendations for the provision of adaptive feedback: For the purposes of this work, we considered (1) performance measures used for the provision of feedback and (2) training evaluation/outcome metrics used

to measure training impact, separately. The provision of feedback is a major focus of this study, with the goal of developing an assessment system capable of supporting embedded, adaptive guidance. We therefore directed our efforts towards developing a conceptual framework to support the content, structure, and provision of adaptive guidance during trauma team simulations. This work relied heavily on the training, education, and debriefing literatures. In Attachment 3 we list feedback principles, scientific rationale, and, where appropriate, exemplars for simulation-based training.

Cross reference feedback principles and team training architecture with TeamSTEPPS terminology: The investigators attended the 2016 IPR held in Fort Detrick, MD. There, they presented preliminary work and received constructive feedback both in person and via written review. Since the IPR, the investigators addressed each point made by the panel and specific comments made by COL. Hopkins-Chadwick during a phone meeting. We added an additional item to our task list (Task 5a) that we feel clarifies our work and improve usability by military units. This task has since been completed and Attachments 1-3 reflect these modifications. This completes our response to the Panel and COL. Hopkins-Chadwick.

Deliverables**:** We are preparing a manuscript for submission in the healthcare literature. Planned targets include *Academic Medicine* and *Academic Emergency Medicine*.

Aim 2. Develop and refine a predictive model of trauma team performance and outcomes for use in an adaptive guidance/feedback system

Trauma Simulations and Performance Coding: The purpose of conducting trauma team simulations is to provide baseline data for the design of the BBN. These simulations will be used, along with existing simulation data, to inform the structure of the BBN. Subject recruitment for prospective trauma simulations is completed, and the simulation sessions are underway. We have identified and recruited both civilian and military trauma team leaders. To date we have conducted all of the proposed simulations (n=20). We will continue to perform simulations involving military providers to ensure adequate representation but have collected the data necessary to move ahead with the BBN design and testing.

BBN Structure: We explored several candidate approaches to BBN design. The overall structure determined to be most informative for the purposes of the project is summarized in Figure 5. Briefly, the adaptive performance model presented in Figure 1 was used to identify three core activities relevant to team adaptation: (1) information gathering (encompassing situation assessment activities relevant to formulating/revising diagnoses and establishing goals and team regulation activities related to monitoring and evaluating team actions/progress); (2) communication (encompassing team regulation activities relevant to planning, preparing, and coordinating team behavior); and (3) action (encompassing team regulation activities relevant to making decisions and carrying out task activities). Observable actions reflecting these core activities can then be identified and associated with these concepts (described below, BBN variables). Lastly, this process can be iterated and the core concepts linked across multiple performance events to permit one to make predictions about a team's overall adaptive capacity. This affords the potential to identify and subsequently provide corrective/reflective feedback around core activities of team adaptation (e.g., situation assessment, planning, action, monitoring) based on observations of a specific performance event which generalizes to potential future events. Such feedback encourages individuals and teams to engage in contingency planning, actively evaluate their performance, and make real-time adjustments as needed (i.e., adapt).

To demonstrate proof of concept and evaluate utility, a full version of the BBN for this structure was built using a reduced number of variables (Attachment 4) and data from an existing dataset. This version of the model spans multiple events (intubation, circulatory support, orthopedic stabilization) from our broader trauma simulation; Figure 6a and 6b provides an example of the model for the intubation event. Goals for the model were to minimize model complexity (i.e., number of modeled relationships); directly map variables/relationships represented in the BBN to the adaptability framework developed in Aim 1; incorporate prediction of medical task performance activities into the model; and provide a straightforward means for incorporating feedback guidance on the basis of model predictions.

Figure 5. Proposed BBN approach

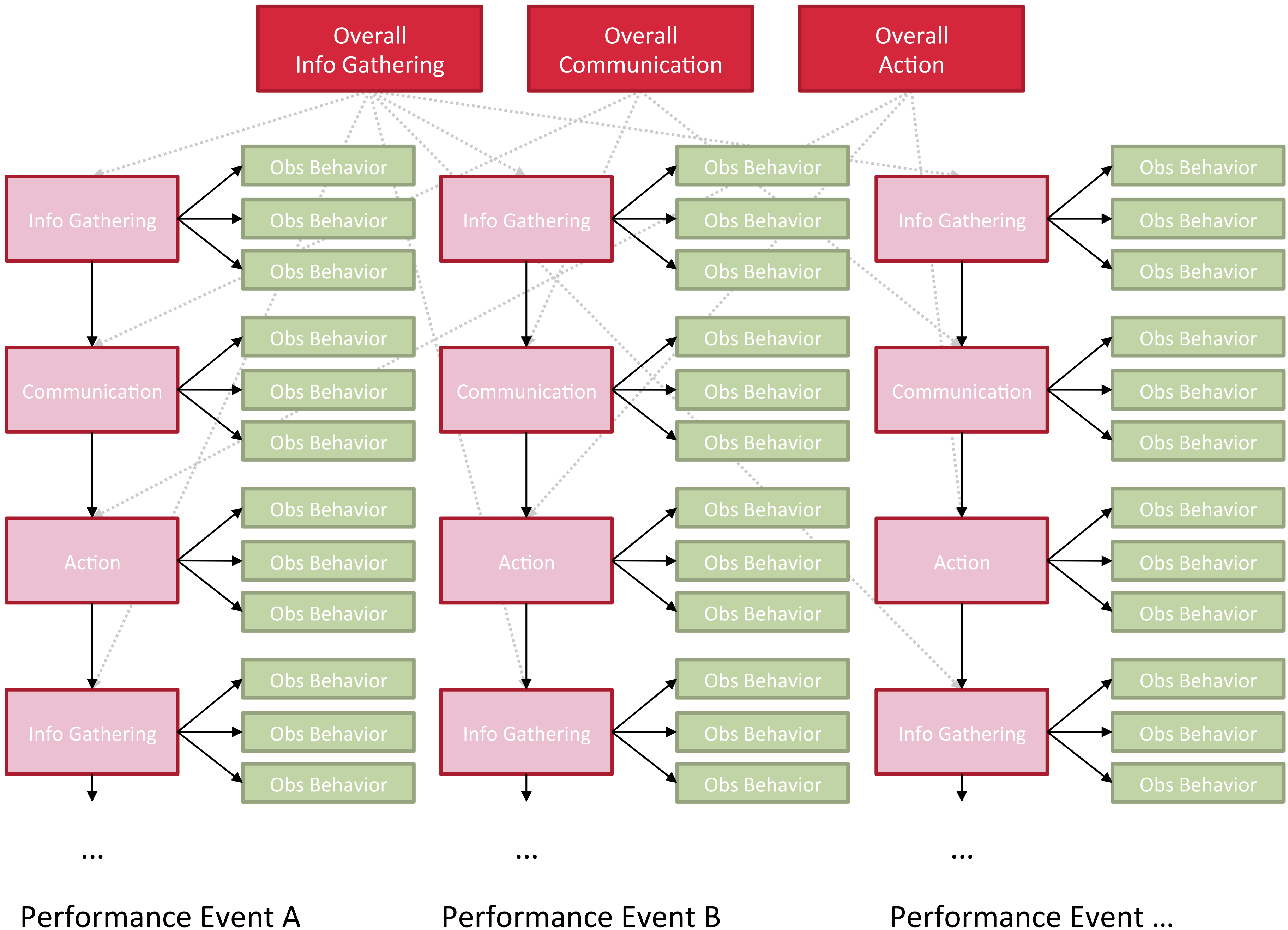
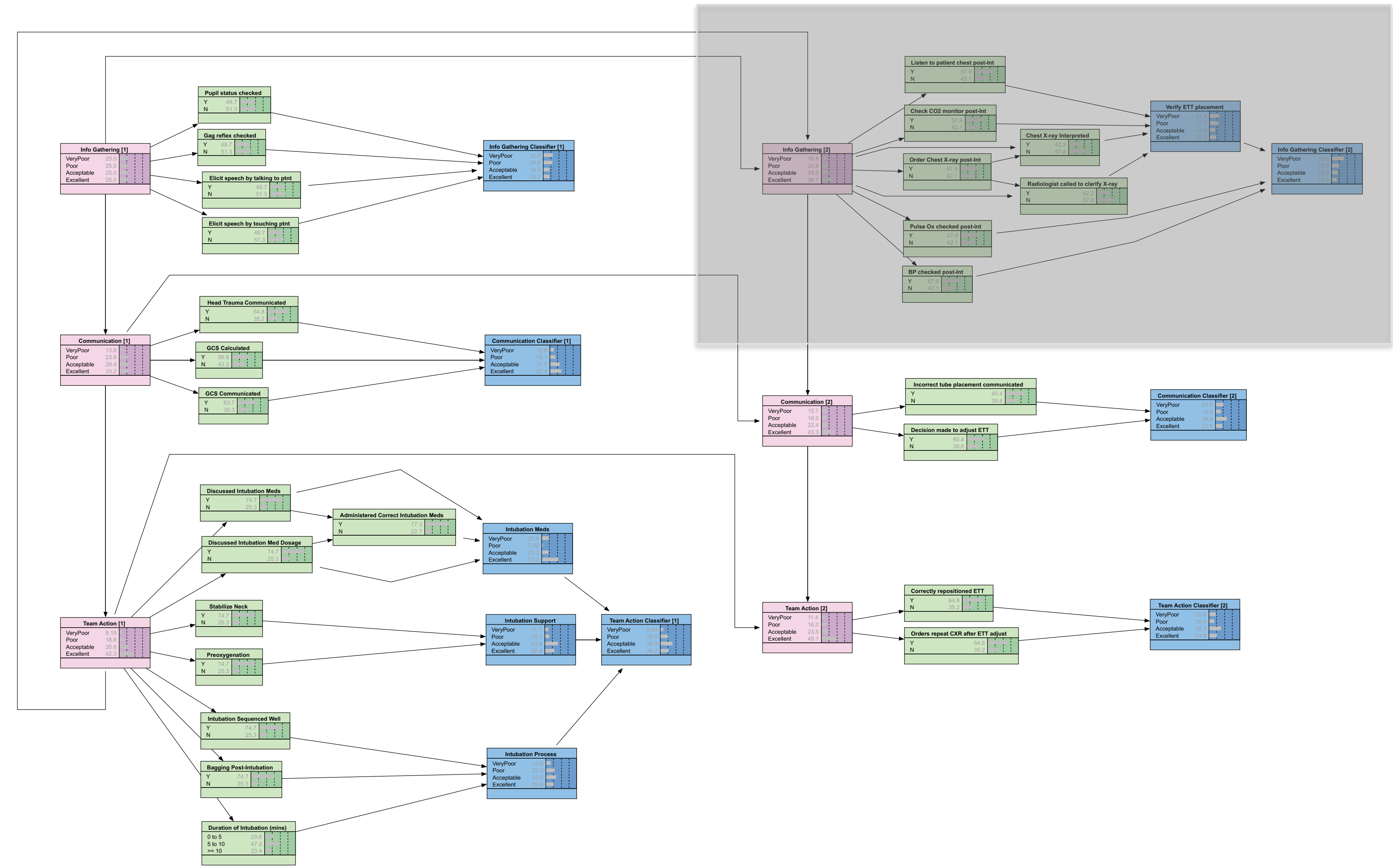
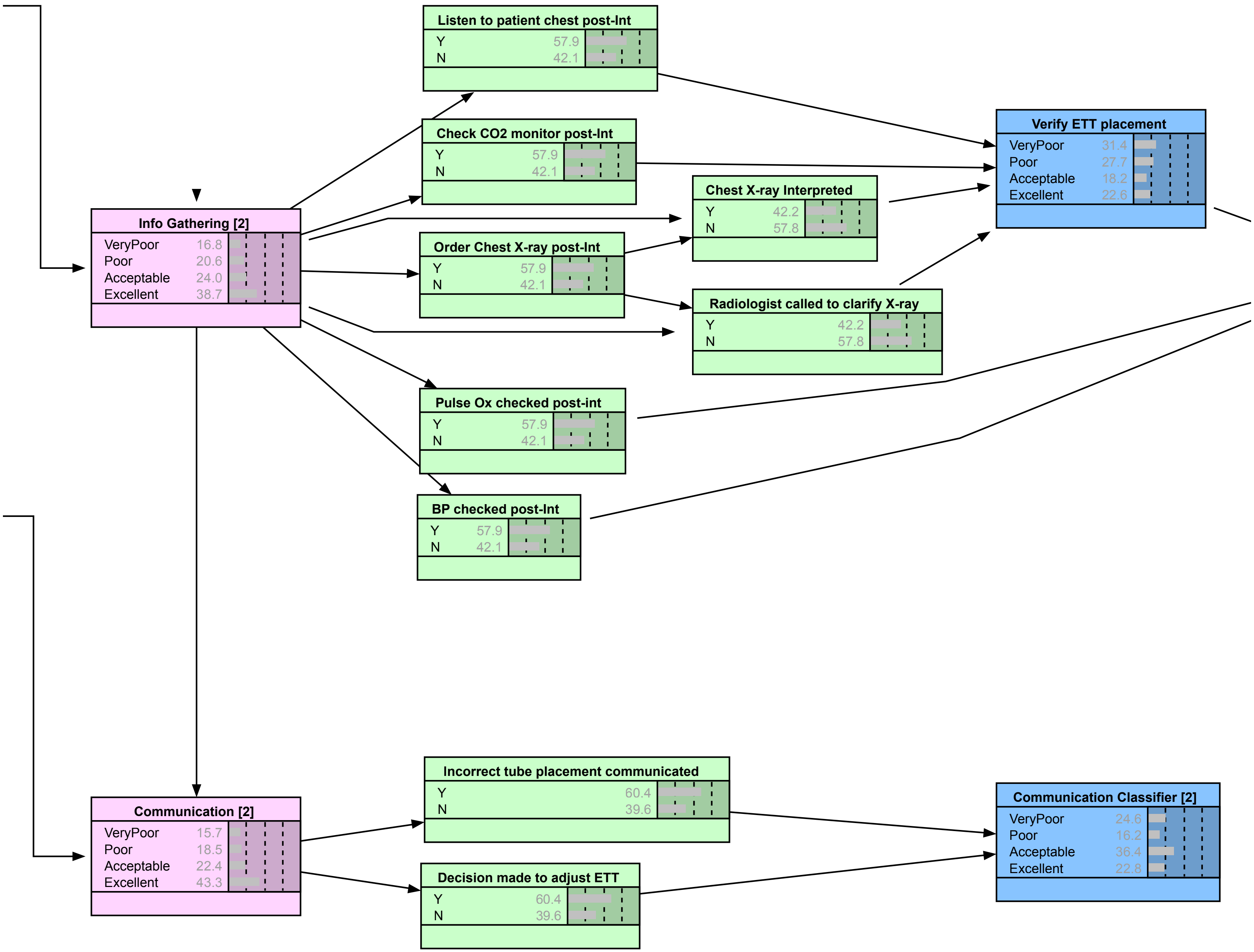


Figure 6a. Sample of BBN structure applied to single performance event (intubation)



*Area in grey expanded in Figure 6b

Figure 6b. Information gathering and communication subcomponents of a single performance event (intubation)



BBN Variables: We reviewed existing datasets for candidate variables appropriate for inclusion in the BBN. This required evaluating over 100 process variables and 80 performance variables. Variables are considered appropriate if there is variability amongst subjects, and if variables correlate with overall performance and process as a whole. A preliminary list of variables was selected and underwent subject matter expert review to determine the appropriateness of variables. We also used subject matter expert input to determine if certain variables should be grouped into composite indicators for inclusion in the BBN. This potentially simplifies BBN input during testing and refinement.

3c. What opportunities for training and professional development has the project provided?
Subjects enrolled in the study received simulation-based trauma team training and assessments. While the provision of training is not a major focus of this project, trainees were able to practice trauma management skills as well as leadership skills under difficult conditions requiring significant individual and team adaptation.

3d. How were the results disseminated to communities of interest?
Dissemination of our work from Aims 1a and 1b is planned for the next year. Specifically, we are preparing two manuscripts, one describing our frameworks, training principles, and concepts related to adaptability and a second related to the provision of adaptive feedback. Adaptive feedback is a relatively new concept within medical simulation and one that needs to be considered within the growing literature around debriefing and the provision of performance-related information. We will also submit this work in the upcoming year to the Military Health System Research Symposium, the Annual Meeting for the Society for Academic Emergency Medicine, and the Annual Meeting for the Human Factors and Ergonomics Society. This will ensure wide distribution of information in military and civilian healthcare arenas as well as within the training and human factors community.

3e. What do you plan to do during the next reporting period to accomplish the goals?

Aim 1a. Develop a team training design architecture to support simulation-based training/assessment systems capable of developing adaptive expertise in health care teams

Aim 1b. Develop evidence-based guidelines and recommendations for the development of embedded, adaptive feedback and performance assessments

Work for Aims 1a and 1b are completed.

Deliverable 1. Health Care Team Training Design Architecture. A unified, evidence-based conceptual framework of health care team training effectiveness that identifies critical variables - individual and team factors, training design elements, and training implementation methods - that can be leveraged to improve team adaptive expertise and performance through robust simulation-based training systems

Deliverable 2. Embedded, Adaptive Guidance: Guidelines and Recommendations. Clear guidelines and recommendations for the design, development, and implementation of embedded, adaptive guidance to optimize team adaptability and team performance

Concepts and principles identified through Aims 1a and 1b will be disseminated in manuscripts during the NCE year. Planned targets include *Academic Medicine* and *Academic Emergency Medicine*. We will also submit this work in the upcoming year to the Military Health System Research Symposium, the Annual Meeting for the Society for Academic Emergency Medicine, and the Annual Meeting for the Human Factors and Ergonomics Society. This will ensure wide distribution of information in military and civilian healthcare arenas as well as within the training and human factors community.

Aim 2. Develop and refine a predictive model of trauma team performance and outcomes for use in an adaptive guidance/feedback system

Trauma Simulations and Performance Coding: The purpose of conducting trauma team simulations is to provide baseline data for the design of the BBN. To date we have conducted all of the proposed simulations. We will continue to perform simulations involving military providers to ensure adequate representation but have collected the data necessary to move ahead with the BBN design and testing. New simulations will be coded on an ongoing basis throughout the next project year.

Generation of Initial Probability Tables for BBN Team Assessment System: The computational "engine" and predictive validity of a BBN relies on the presence of well-informed conditional probability tables (CPTs). A CPT exists for every node in a BBN and reflects the probability that a particular state for a particular node will be observed given the state of all its parent nodes (e.g., *p*(*Chest Compression Quality* = High | *Assign a Team Leader* = No), etc.). In this sense, CPTs represent the degree of interdependency (i.e., correlation) that exists between variables that share a directed arc. To compute the CPTs for the candidate networks, the investigators will utilize their existing dataset to "train" a set of initial conditional probabilities for the modeled variables. This process will entail several steps. First, data must be transformed into an appropriate categorical structure that can be interpreted by a BBN. Next, different learning algorithms will be explored (i.e., counting, expectation-maximization, gradient descent) in an attempt to produce the "maximum likelihood BBN," or the set of CPTs that is most likely given the observed data. The fit of the algorithms will be assessed using standard model evaluation techniques (e.g., confusion matrix, times surprised, etc.); additionally, these metrics will be used to compare candidate BBNs to identify the best fitting model. Finally, in instances where data is unavailable or insufficient to generate a suitable CPT, existing empirical literature (i.e., meta-analyses) and/or subject matter experts will be relied upon to generate the nature of the conditional dependence. The result of this step will be development of the best fitting, functional prototype BBN team assessment system based on existing data.

BBN Team Assessment System Calibration: A potential concern with using only a single sample to construct a BBN is that the model and its accompanying CPTs may be "overfit" and fail to generalize beyond the training data. Thus, in the final step of development, the performance of the BBN team assessment system will be evaluated and recalibrated using the new data collected through coding of simulations. A similar approach to evaluating model fit as described above will be implemented to examine the adequacy of the BBN's predictions in the new data. To the extent that misfits among particular nodes or relationships are identified, the investigators will rely on subject matter experts and empirical evidence from the literature to identify whether and/or how to adapt the BBN (adjust CPTs, specify new nodes/variables, revise causal pathways). Irrespective of fit, the new data can be used to improve the precision of the BBN assessment model through added observations. The results of this step will thus be improvement and calibration of the prototype BBN team assessment system.

4. Impact for Project Year 2 Work

4a. What was the impact on the development of the principal discipline(s) of the project?

Our work will improve training, maximize healthcare provider performance, and minimize morbidity for our injured service men and women. Once disseminated, the work from project year one will provide military and civilian healthcare providers and educators with clear guidelines for the development of training that builds adaptive capacity. Specifically, we provide developmentally appropriate training targets for individuals and teams. We identify what training content and delivery method is most appropriate for developing adaptive behaviors around certain types of tasks. We recognize that frontline medics adapt to different situations than physicians in specialty clinics and our guidelines account for these differences. We aim to provide a clear, easily applied method to help educators and trainers make decisions regarding training development and implementation. Our work will facilitate the development of longitudinal curricula across multiple specialties and disciplines by providing clear training targets for individuals and teams at all levels of performance.

The guidelines and principles for adaptive feedback introduce a new and important concept to healthcare. The provision of "feedback" and "debriefing" in experiential training has been identified as critical to learning. However, the role for adaptive feedback in the development of highly adaptive teams has not been described. We will disseminate our review of the topic along with specific recommendations for implementation within simulation-based training. Along with the work to be performed in Aim 2, this information will provide the foundation for the development of simulation-based training with automated, adaptive feedback.

The development of a predictive model of trauma team performance is underway. When completed, this work will apply a novel approach to the provision of adaptive guidance and feedback during team performance. This will not only advance our understanding of successful team performance, but will also inform educators about how the delivery of feedback and guidance can impact adaptive performance.

4b. What was the impact on other disciplines

Our work has impact beyond healthcare. We highlight the challenges associated with training and evaluating performance in complex environments. This information is useful in human factors and organizational psychology, where teamwork has often been considered a static construct, rather than a dynamic entity where teams learn, adapt, and react to continuous changes in the task, environment, and team. Our framework highlights how important it is to consider characteristics of the task(s) necessitating adaptation when developing training programs. This work provides a foundation to build more comprehensive training that goes beyond TeamSTEPPS-type training to impact complex teams performing in highly dynamic, potentially dangerous situations. Additionally, the application of BBNs as an analytical framework has primarily been restricted to problem domains within engineering and ecology. The use of these techniques for modeling individual and team behavior as well as for guiding the delivery of feedback is both novel and highly generalizable. With respect to healthcare applications, the application of BBNs we have pursued to model team performance can be extended to all disciplines within healthcare, including forward military units, ambulatory care centers, and long-term rehabilitation units. The use of adaptive guidance can be incorporated into automated, online training as well as mannequin-based simulation curricula.

4c. What was the impact on technology transfer?

Nothing to report

4d. What was the impact on society beyond science and technology?

Failure to adapt to rapidly changing conditions is a primary cause of medical error. In military settings, such failures can also lead to significant harm to providers. Our work has a significant impact on patient safety, decreasing soldier morbidity and mortality, and on patient satisfaction. Simulation is a key modality leveraged by the military to advance expertise and ensure that soldiers receive the highest level of clinical care. Significant human and technological resources are dedicated to developing and implementing rigorously tested, high-quality simulation-based curricula. Clear guidelines and a training framework focused on developing adaptive capacity did not exist. We fill this gap and, in doing so, provide an important mechanism to support the development and implementation of highly effective individual and team-level healthcare training.

5. Changes / Problems

5a. Changes in approach and reasons for change

There are no anticipated changes in approach.

5b. Actual or anticipated problems or delays and actions or plans to resolve them

PI Relocation: The PI, Rosemarie Fernandez is relocating to the University of Florida- Jacksonville at the beginning of January. This move will not change the scope of the work to be completed nor result in any changes to the budget. We fully anticipate completing the work proposed for the NCE year.
Team engagement: The team will continue to meet weekly via GoToMeeting. Dr. Fernandez will use funds set aside for travel to have at least one in-person meeting in Seattle to facilitate the final components of the project.
Budget: The team will continue to execute the proposed work. There are adequate funds available and both institutions (University of Washington and University of Florida – Jacksonville) agree to the terms of the new budget. We therefore do not anticipate any issues.

Simulation delay: Scheduling the simulations was slightly delayed due to the residents' (subject) clinical schedules. Simulations are complete. To ensure adequate military representation, we continued executing simulations through the beginning of the NCE year to obtain the maximal amount of military subject data. To augment simulation performance and coding, we've added a co-investigator (M. Vrablik) to the research team. We are able to do this while staying within the proposed budget. We do not anticipate any additional delays.

Subject Matter Expert Input: We elected to get further input from our subject matter experts for the BBN variables and relationships. This pushed the BBN testing and calibration to the NCE year. This work is underway and does not reflect a change in the approach. The work for Aim 2 will still be completed within the proposed budget.

5c. Changes that had a significant impact on expenditures

The project is currently on budget. Delays in hiring the research assistant and delay in starting simulations have shifted some of the costs to the NCE year. Subcontract costs are encumbered now for years 1 and 2. The slight delays described above do not impact the budget, and we fully anticipate completing the project within the proposed budget.

5d. Significant changes in use or care of human subjects, vertebrate animals, biohazards, and/or select agents

None. While we increased our simulation subjects to 22 teams, this protocol is exempt and no further action is needed.

6. Products

6a. Publications, conference papers, and presentations

1. Fernandez R, Rosenman ER; Santoro J, Pacic E, Golden SJ, Brolliar SM, Chao GT, Grand JA, Kozlowski SWJ. A multicenter, observational study of teamwork, team cognition, and leadership. *2016 Military Health System Research Symposium*, Orlando, FL.
2. Rosenman ED, Dixon AJ, Webb JM, Brolliar SM, Golden SJ, Jones KA, Shah S, Grand JA, Kozlowski SWJ, Chao GT, Fernandez R. A simulation-based approach to measuring team situational awareness in emergency medicine: A multicenter, observational study. *Acad Emer Med* (doi:10.1111/acem.13257).

6b. Website or other Internet sites

None

6c. Technologies or techniques

None

6d. Inventions, patent applications, and/or licenses

None

6e. Other products

None

7. Participants & Other Collaborating Organizations

7a. What individuals have worked on the project?

Name:	Rosemarie Fernandez, MD
Project role:	Principal Investigator
era Commons ID:	av9546
Nearest person month worked:	2.4 cal. Months (0.2 FTE)
Contribution to project:	Worked with ER to review actual trauma resuscitations and identify missing components of the conceptual framework. Worked with JG, ER, GC to address issues raised during IPR. Recruited subjects for simulation and executed simulations. Worked with ER, JG to help define the BBN structure and develop a prototype.

Name:	James Grand, PhD
Project role:	Co-Principal Investigator
era Commons ID:	Grandjam
Nearest person month worked:	3 cal. Months (0.25 FTE)
Contribution to project:	Worked with GC to conduct team science component of literature review. Worked with RF, ER, GC to address issues raised during IPR. Led efforts in the development of the BBN structure and develop a prototype.

Name:	Elizabeth Rosenman, MD
Project role:	Co-Investigator
Nearest person month worked:	1.2 cal. Months (0.1 FTE)
Contribution to project:	Worked with RF to review actual trauma resuscitations and identify missing components of the conceptual framework. Worked with JG, RF, GC to address issues raised during IPR. Recruited subjects for simulation and executed simulations. Worked with RF, JG to help define the BBN structure and develop a prototype.

Name:	Georgia Chao, PhD
Project role:	Co-Investigator
Nearest person month worked:	2 cal. Months (0.19 FTE)
Contribution to project:	Worked with JG to conduct team science component of literature review. Worked with RF, ER, JG to modify conceptual framework. Identified team science-related training principles and recommendations.

Name:	CPT. Lindsay K. Grubish, DO
Project role:	Military investigator
Nearest person month worked:	0.6 cal months (0.05 FTE)
Contribution to project:	Provides military subjects and acts as subject matter expert for military medicine.

Name:	Ly Huynh, BA
Project role:	Research assistant
Nearest person month worked:	6 cal. Months (0.5 FTE) – STARTED 11/2016
Contribution to project:	Replaced K. Jackson. Coordinated subject recruitment, worked with simulation center to schedule and execute simulations. Worked on developing comprehensive database and secure transfer of data.

Name:	Benjamin Levine, BA
Project role:	Graduate student research assistant
Nearest person month worked:	6 cal. Months (0.5 FTE)
Contribution to project:	Worked with team to develop BBN approach and development of prototype BBN with relationships.

Name:	Jessica Santoro, MA
Project role:	Graduate student research assistant
Nearest person month worked:	1 cal. Months (will be at 0.5 FTE for upcoming project year)
Contribution to project:	Assisted with development of adaptive feedback principles, performed related literature review, linked principles with TeamSTEPPS principles.

7b. Has there been a change in the active other support of the PD/PIs or senior/key personnel since the last reporting period?

We added CPT. Lindsay K. Grubish, DO to the project, as Dr. Jay Baker took a new position and is no longer able to assist with the project. CPT. Grubish is a staff physician in the Department of Emergency Medicine at MAMC. She has experience using simulation to assess performance in military medical providers under stress. She will be responsible for providing subject matter expertise and recruitment of military residents for the simulations. Attached is her Biosketch (Attachment 5).

As noted above, we added Dr. Marie Vrablik to the project to assist with coding of videos (Biosketch Attachment 6).

7c. What other organizations were involved as partners?

University of Maryland
Department of Psychology
College Park, Maryland
The Co-PI, Dr. Grand, and a graduate student, Mr. Benjamin Levine, are both supported at the University of Maryland. There, they have office space, computer access, and support for virtual meetings with the research team.

Madigan Army Medical Center
9040 Jackson Ave.
Tacoma, WA 98431
Co-I: CAPT. L. Grubish
CAPT. Grubish will assist with subject matter expert queries and will also assist with simulations and performance coding.

Eli Broad College of Business / Michigan State University
East Lansing, Michigan
Dr. Chao (collaborator) and a graduate student, Ms. Jessica Santoro, are both supported at Michigan State University. There, they have office space, computer access, and support for virtual meetings with the research team.

8. Special Reporting Requirements

8a. Collaborative Awards
N/A

8b. Quad Chart
Please see Attachment 7 for updated Quad Chart.

ATTACHMENTS

Attachment 1: Training principles to target adaptive processes at different levels.

Principle and Applicable Level(s)	Rationale	Simulation application	TeamSTEPPS Associations
Use pre-training materials to provide appropriate orientation to trainees. (Individual Level)	Pre-training materials presented at the start of training provide an initial organizing structure of the subject matter discussed in training. Pre-training materials provide conceptual information, help to build connections between similar ideas, and delineate different concepts from one another. Trainees who use or begin to develop their own pre-training materials are more likely to adaptively transfer knowledge and skills.	• Inform trainees about training focus. This does not necessarily mean informing them of key critical content planned for simulations; rather, tell trainees they will be focusing on team (or individual) skills • Suggest that trainees consider personal strengths and weaknesses prior to coming to training.	• No associations
Promote trainees to have a learning goal orientation during training. (Individual and Team Level)	Training design that promotes a learning goal orientation (e.g., a focus on self-improvement and task mastery in achievement situations) has been linked to positive training outcomes, such as goal setting, self-regulatory activities, learning, and performance. This is in stark contrast to promoting a performance goal orientation (e.g., a focus on demonstrating ability to others in achievement situations) which has been shown to negatively relate to goal striving processes and performance.	• Promote a learning goal orientation by encouraging trainees to set goals about achieving learning objectives and acquiring relevant knowledge and skills. • Establish psychological safety	• Psychological safety is about being able to take interpersonal risks on a team. The concept of psychological safety has similarity to TeamSTEPPS' mutual trust dimensions of "advocacy and assertion" and "two-challenge rule". These two dimensions discuss the role of speaking up about decisions being made within the team. The advocacy and assertion piece asks team members to voice new viewpoints that clash with the leader's viewpoint. They are asked to assert themselves firmly and respectfully. The two-challenge rule piece describes that if an initial assertion goes unanswered, the team member should assert at least twice to ensure their viewpoint is heard. (Ferguson, p. 123)
Trainees should be provided with higher-level coordination strategy instruction later in training once appropriate foundational knowledge has been developed. (Individual)	The KSAs required to effectively engage in individual and team adaptation are advanced learning outcomes. Without achieving proficiency in the basic and procedural knowledge necessary to carry out core task/job requirements in a domain, efforts to improve the adaptation process will be less effective.	• Assess individuals for team-based simulation "readiness" • Use low fidelity non-clinical simulations to begin building team skills while individuals are still developing clinical knowledge. • At this stage, interdisciplinary training is not important; however institutions should ensure consistency of curriculum across professions/units/schools	• No associations

Adopt a **Crawl-Walk-Run** approach to training design. Training material should be structured so that instruction proceeds from general to detailed, specific to complex. (Individual and Team Level)	Successful team adaptation requires integrating, coordinating, and regulating a variety of different KSAs, resources, and members. Developing the capacities to manage these processes should be built around a Crawl-Walk-Run curriculum model to allow learners to first achieve basic competencies and then practice/engage in more complex applications. Note that this also applies to actively training members as part of intact teams -- team-based training designed to enhance adaptability is a complex environment and should be postponed until learners have engaged in more foundational training exercises.	• Team-based simulations should initially use basic clinical scenarios rather than unusual or highly complex situations. Once basic team skills have transferred from "non-clinical" simulations (above) to straightforward clinical issues, more complex team and environmental issues can be added. • Use EBAT to create a simulation experience where modules can be added to model more complexity as well as to target specific team skills.	• No associations
Trainees learning a complex task should be encouraged to monitor rate of learning progress rather than just learning performance. (Individual Level)	Training that emphasizes learning trajectories, development, and velocity is more likely to minimize goal abandonment, promote self-efficacy, and encourage trainees to view training as "learning" rather than "evaluation." Additionally, emphasizing "future-focused" cognitive appraisals (i.e., focusing on how learning outcomes/capabilities are evolving) reinforces the cognitive appraisal frames critical to team adaptation.	• During pre-brief, make it clear to learners that there may be no "right answer". • Establish a learning environment that supports psychological safety. • If using a modular EBAT approach, consider guiding teams to recognize how similar problems were addressed in the past so they can monitor their progress.	• Psychological safety is about being able to take interpersonal risks on a team. The concept of psychological safety has similarity to TeamSTEPPS' mutual trust dimensions of "advocacy and assertion" and "two-challenge rule". These two dimensions discuss the role of speaking up about decisions being made within the team. The advocacy and assertion piece asks team members to voice new viewpoints that clash with the leader's viewpoint. They are asked to assert themselves firmly and respectfully. The two-challenge rule piece describes that if an initial assertion goes unanswered, the team member should assert at least twice to ensure their viewpoint is heard. (Ferguson, p. 123)
Trainees learning complex tasks should be provided with proximal subgoals that break the task into smaller parts. (Individual and Team Level)	Team adaptation is a process characterized by an ongoing cycle of situation assessment and team/task management. The KSAs which underlie successfully execution of these stages can be developed through "part-learning" and by breaking the adaptation process into meaningful chunks. This approach is more likely to increase learner self-efficacy and persistence, and allow practice opportunities & feedback to be tailored towards more focused learning objectives.	• Break down adaptive behaviors into clear activities that can be practiced in isolation. If necessary, remove learners from the clinical setting to work on key activities prior to re-entering a high-fidelity simulation.	• No associations

Trainees presented with extremely difficult problems that appear unsolvable should be assisted in making some consistent progress during training. (Individual Level)	The structure of the training environment and practice opportunities for team adaptability should not be "sink or swim" (esp. during initial stages of practice). Feedback and direction that actively guides teams through how to think through a complex task and make decisions about resources is a critical foundation of team adaptability training. Providing guidance that prompts teams to explore options for task completion during training helps to avoid discouragement, anxiety, and abandonment of effort.	• Use triggers and backup triggers during simulations to allow learners to attempt the behavior and, if unsuccessful, observe an "expert" (confederate) execute the behavior with success. • Junior learners that may lack clinical knowledge should be encouraged to seek assistance for help at any time. Using confederates as "mentors" can not only assist learners through difficult tasks but also will build comfort with seeking help from other team members and those outside the team.	• In performance episodes, task assistance occurs through TeamSTEPPS' mutual support tool when "team members foster a climate where it is expected that assistance will be actively sought and offered" (Ferguson, p. 123)
Variability in practice trials should be provided during training to maximize retention & transfer. (Individual and Team Level)	Whereas early stages of training are enhanced by repetition and rehearsal (i.e., developing declarative & procedural knowledge), advanced stages of training are enhanced by exposing trainees to as diverse an array of scenarios in which to apply their KSAs as possible. It is particularly critical to expose trainees to situations where previously learned, frequently used, and/or typically reliable courses of action are ineffective. Providing variability in practice trials promotes the development of broader associative knowledge structures and contingency-based thinking.	• Use EBAT to build simulations that contain appropriate task complexity • Shorten intervals between prompts to increase time pressures as appropriate. • Use confederates to add interpersonal challenges. • Build in environmental challenges (e.g., additional patients, equipment failure) to increase complexity	• No associations
Training should be permissive of, embrace, and even encourage errors made by learners during training. (Individual and Team Level)	Errors are an inevitable component of real-world performance. Errorless training leads to effective training performance, but is often related to poor training transfer. Although errors during training should be brought to learners' attention, learning that is focused on error management as opposed to error prevention is more successful. Framing training as an opportunity to make and learn from errors encourages trainees to develop problem-solving or hypothesis-testing skills and strategies for managing affective responses (e.g., frustration and anxiety).	• Use confederates to "force" errors during simulations. This requires considerable expertise in debriefing to ensure learners do not feel "tricked". Appropriate pre-briefing and establishment of a learning environment can help. Be sure that "errors" meet a minimum level of psychological fidelity for learners.	TeamSTEPPS takes a slightly different view of errors and does not specifically address the use of errors in training. • TeamSTEPPS argues that *performance* should be error free, but does not talk about the conditions for training. They advocate for situation monitoring whereby team members monitor the actions of other team members for the purpose of reducing and avoiding errors. (Ferguson, p. 123) • TeamSTEPPS would advocate for team members to monitor the environment to look for these errors so that they are caught "quickly and easily". They encourage for team members to watch each other's backs.

Incorporate lessons on how to alter coordination strategies in training. (Team Level)	When task demands are low, trainees should learn to discuss possible problems that could arise later in the task. By discussing their coordination strategies during this period, they will likely reduce the amount of communication necessary to achieve successful team performance later and allow them to be adaptive when novel problems arise in the environment.	• Encourage learners to develop contingency plans • Discuss team member understanding and mental model development during debriefing to help reinforce the importance of discussing and practicing team coordination	• TeamSTEPPS offers the leadership tool called the “brief”, which is a “short session prior to start to share the plan, discuss team formation, assign roles and responsibilities, establish expectations and climate, anticipate outcomes and likely contingencies”. (Pocket Guide, p. 16) • Use of the term “mental model” is consistent with TeamSTEPPS language. A situation monitoring tool is the shared mental model, which Ferguson defines as “the perception of, understanding of, or knowledge about a situation or process that is share among team members through communication. Having team members on the same page is the desired team outcome.” (p. 123) • Debriefing in TeamSTEPPS is referred to as “Process improvement – Debrief” where an after-action review is used “to provide feedback and improve team performance”. (Ferguson, p. 123)
Integrate metacognitive prompts into training. (Individual Level)	Metacognition is the process of actively reflecting on one’s thought processes. Encouraging metacognitive activity during training can help learners identify and focus on the goals, assumptions, and strategies guiding their decision-making and task performance. This is especially important for less experienced trainees learning to perform in complex and dynamic environments and who may struggle with such “big picture” thinking.	• Employ “think aloud” protocols during simulation-based training in which the trainee verbalizes their thought process during practice • Build in opportunities for more frequent huddles during simulation-based training in which the trainee is prompted to explicitly discuss their rationale for previous decisions and considerations for future plans.	• TeamSTEPPS encourages talking out loud even during performance episodes. It’s referred to as a “call-out” where team members are informed simultaneously. While this isn’t a “thinking” procedure, the two methods are similar in the way that they are performed.

Attachment 2. Identifying Task Complexity and Associated Best Practice Training Principles

<u>Adapting to changes in Component complexity</u> Changes in number and/or difficulty of tasks		**<u>Adapting to changes in Coordinative complexity</u>** Changes in sequencing, prioritization, & interdependence among tasks		**<u>Adapting to changes in Dynamic complexity</u>** Volatility in component & coordinative complexity within a task	
Principle	**Rationale**	**Principle**	**Rationale**	**Principle**	**Rationale**
Trainees should not be provided complex coordinative instruction until later in training	Emphasizing breaking down tasks into subtasks and how to complete small numbers of simple, manageable tasks during early knowledge/skill acquisition promotes self-efficacy and draws focus away from premature comparative & normative evaluations	Trainees should not be provided complex, coordinative instruction until later in training	Shifting training towards prioritization, how to develop contingencies*, and managing distal vs. proximal goals once trainees have achieved proficiency in basic knowledge and skill promotes mastery learning and promotes "big picture" thinking	Trainees should not be provided complex, coordinative instruction until later in training	Shifting training towards recognizing when change is needed and when/how to implement contingencies* focuses trainees appropriately on normative expectations and being proactive.
Training material should be structured so that instruction proceeds from general to detailed, specific to complex	Training experiences should support trainees learning to deal with few/simple tasks --> more/simple tasks --> few/difficult tasks --> more/difficult tasks. This enables training/feedback to focus on quantity vs. complexity of tasks, which pose different considerations	Training material should be structured so that instruction proceeds from general to detailed, specific to complex	Training experiences should support trainees learn to deal with few/simple tasks --> more/simple tasks --> few/difficult tasks --> more/difficult tasks. This enables training/feedback to focus on quantity vs. complexity of tasks, which pose different considerations	Training material should be structured so that instruction proceeds from general to detailed, specific to complex	Training that allows practice shifting from few/simple tasks to more/complex tasks *within the learning environment* allows learners to practice situation assessment and task regulation cycles under different demands
Trainees learning a complex task should be encouraged to monitor rate of learning progress rather than just learning performance	Focusing feedback on how and what KSAs trainees have developed that **involve managing different quantities of tasks** minimizes goal abandonment and promotes learning how to deal with situations where resources (time, persons, etc.) are strained	Trainees learning a complex task should be encouraged to monitor rate of learning progress rather than just learning performance	Focusing feedback on how and what KSAs trainees have developed that **involve managing tasks with fewer vs. more interdependencies and considerations** minimizes goal abandonment and promotes learning how to deal with situations where resources must be highly coordinated	Trainees learning a complex task should be encouraged to monitor rate of learning progress rather than just learning performance	Focusing feedback on how and what KSAs trainees have developed that are **involve managing sudden changes in task demands** minimizes goal abandonment and promotes learning how to deal with situations where resources must be quickly assessed, gathered, and distributed
Provide & emphasize proximal subgoals that allows trainees to break task down into	Focusing on how to deal with multiple competing demands and strained resources improves capacity to manage tasks	Provide & emphasize proximal subgoals that allows trainees to break task down into	Focusing on how to prioritize and structure task activity improves capacity to make informed decisions & communicate what must be	Provide & emphasize proximal subgoals that allows trainees to break task down into	Focusing on how to deal with variability in task demands/resources within a single performance event improves capacity to shape

<u>Adapting to changes in Component complexity</u> Changes in number and/or difficulty of tasks		**<u>Adapting to changes in Coordinative complexity</u>** Changes in sequencing, prioritization, & interdependence among tasks		**<u>Adapting to changes in Dynamic complexity</u>** Volatility in component & coordinative complexity within a task	
Principle	**Rationale**	**Principle**	**Rationale**	**Principle**	**Rationale**
manageable components	where demands >= supply	manageable components	accomplished to reach task goals	manageable components	and implement contingencies*
Variability in practice trials / simulated clinical events should be provided during training to maximize retention & transfer	Practicing multiple situations with fewer/simple, fewer/difficult, more/simple, more/difficult exposes trainees to more exemplars, prepares them for more situations, and encourages flexible modes of thinking/problem-solving (Crawl-Walk-Run)	Variability in practice trials / simulated clinical events should be provided during training to maximize retention & transfer	Practicing multiple situations with fewer/simple, fewer/difficult, more/simple, more/difficult exposes trainees to more exemplars, prepares them for more situations, and encourages flexible modes of thinking/problem-solving (Crawl-Walk-Run)	Variability in practice trials / simulated clinical events should be provided during training to maximize retention & transfer	Practicing situations that transition from fewer/simple, fewer/difficult, more/simple, more/difficult *within the learning environment* exposes trainees to more exemplars, prepares them for more situations, and encourages flexible modes of thinking/problem-solving (Crawl-Walk-Run)
Trainees should be encouraged to experience errors	Errors of omission & commission are common stimulus for adaptation.* Placing trainees in situations where few vs. many, little vs. big, salient vs. subtle, etc. errors are likely and/or have happened reinforces situation awareness and decision-making skills in unexpected and unplanned situations	Trainees should be encouraged to experience errors	Errors of omission commission are common stimuli for adaptation. Placing trainees in situations where errors push them down a wrong path reinforces situation awareness and decision-making skills in unexpected and unplanned situations	Trainees should be encouraged to experience errors	Errors of omission & commission are common stimuli for adaptation. Placing trainees in situations where tasks change suddenly and errors are more likely reinforces situation awareness and decision-making skills in unexpected and unplanned situations

*TeamSTEPPS includes several concepts that are consistent with the material above. Specifically, TeamSTEPPS supports the idea of a “brief” where planning behaviors support the ability of teams to prioritize their work and develop contingency plans that facilitate the ability to adapt quickly in response to changes. TeamSTEPPS also emphasizes monitoring behaviors, which enable teams to detect changes that require them to adapt their approach. TeamSTEPPS also describes the need to monitor team members to help prevent errors. Key TeamSTEPPS concepts are summarized here:

Brief: Encourages team members to share their **plan**, assign roles and responsibilities, anticipate outcomes and likely contingencies. (Pocket Guide, p. 16)
Monitoring: TeamSTEPPS’ situation monitoring refers to monitoring “progress toward goals and identifying changes that could alter the plan.” TeamSTEPPS encourages team members to monitor their environments for errors. Specifically, situation monitoring includes monitoring “fellow team members to ensure safety and prevent errors” (Pocket Guide, p. 32)
Leadership: TeamSTEPPS believes that effective team leaders should organize the team, identify clear goals, assign tasks and responsibility, monitor and modify the plan, communicate changes to the plan, provide feedback when needed, manage and allocate resources, and facilitate information sharing. (Pocket Guide, p. 15)

Attachment 3. Principles of providing adaptive feedback

Principle 1. Trainees should be provided with accurate and credible feedback.
Ensuring feedback is accurate helps trainees understand what task behaviors need improvement. Making feedback credible/authentic improves the likelihood that trainees perceive the feedback as something important to which they should attend. There are instances in which the accuracy of feedback should be "altered" if it benefits self-efficacy and effort of trainees (e.g., learning a complex task that results in many mistakes, poor training performance, etc.) TeamSTEPPS and other training programs support the provision of feedback but do not provide concrete recommendations to ensure delivery of *adaptive* feedback.
Simulation Recommendations:
- Explain learning objectives to trainees and explain clear benchmarks for performance. By setting benchmarks, trainees can see where their performance gaps lie. Setting benchmarks also helps ensure feedback is diagnostic.
- The feedback facilitator should have significant skill in debriefing techniques.
- Consider pairing a content expert with feedback expert when needed

Principle 2. The frequency and timing of feedback should be appropriately tailored to trainees and the goal of training.
In general, directive, immediate, and frequent feedback tends to facilitate the acquisition of declarative & procedural knowledge and improve learner's self-efficacy. However, when the goal of training is to promote how to identify and handle errors and/or develop strategies and contingency-based thinking, feedback should be less frequent to discourage trainees from assuming there is "one correct answer" they should be learning.
Simulation Recommendations:
- Process feedback should be more frequent than outcome feedback
- With more experienced teams, moving from a formalized feedback to facilitation of a high-level debrief that allows objectives to emerge based on performance and team challenges might be more appropriate
- When performing a more high-level debrief, it should occur as close to the event as possible
- Be sure to build in adequate time for debriefs, usually a minimum of 2x the length of the simulation
- Ensure that the simulation objectives are finite and can be covered during the debrief
- Build in feedback delivery mechanisms into the Crawl-Walk-Run training framework

Principle 3. Feedback related to practice behaviors and clinical performance strategy development should be specific.
When it is appropriate to provide such feedback (see principle above), feedback about the behaviors in which trainees engaged; how, why, and what clinical performance strategies trainees attempted to implement; and the manner by which they addressed errors or unexpected events should be specific and detailed. Providing specific feedback facilitates the retention and automatizing of learned material and helps to avoid ineffective strategy or behavioral changes.
Simulation Recommendations:
- Ensure that team members have a working knowledge of team processes prior to executing the simulation; this will allow the facilitator to use this common language during the debrief
- Refer to specific examples during the simulation to highlight strengths and weaknesses of team process.
- Video review may be helpful
- Providing individuals with feedback is important; however, must be done with care in a team debrief
- Using self-assessment "cognitive aids" can help individuals assess their contribution to team performance. One example would be the TeamSTEPPS debrief checklist available in the TeamSTEPPS Pocket Guide
  - Was communication clear?
  - Were roles and responsibilities understood?
  - Was situation awareness maintained?
  - Was workload distribution equitable?
  - Was task assistance requested or offered?
  - Were errors made or avoided?
  - Were resources available?
  - What went well?
  - What should improve?

Principle 4. Feedback should be more heavily focused towards process rather than outcome.
Outcome feedback conveys the extent to which trainees met/are meeting learning objectives. Alternatively, process feedback focuses on how trainees are using information, performing behaviors, and the steps used to complete task activities. Process feedback directs learners to reflect on the strategies and decisions that led to particular outcomes, and is thus particularly important when the goal of training is to improve regulatory/strategic thinking.
Simulation Recommendations:
- Allow teams to discuss medical content and address any concerns quickly to help learners focus on processes of care
- Encourage learners to consider other circumstances where similar processes are employed and can fail. This helps team focus on processes instead of the specific clinical issues presented in the simulation.

Principle 5. Trainees should be encouraged to believe substantial negative performance discrepancies are moderate.
Acquiring KSAs in complex task environments is challenging, and learners are not likely to perform well during initial stages of training. Providing accurate and credible feedback is important, but it is equally critical to ensure that trainees do not become overwhelmed and/or discouraged by actions they have performed incorrectly. This balance can be achieved by framing feedback such that: (1) feedback emphasizes trainee performance is attributable to controllable factors; (2) feedback de-emphasizes outcome-focused feedback in favor of process feedback and feedback that highlights how learners are developing; (3) initially poor performance be labeled as only moderately negative. Doing so decreases the likelihood of goal abandonment while increasing the likelihood that effort and self-efficacy will be maintained.
Simulation Recommendations:
- Encourage learners to note positive as well as negative behaviors (What should you change? What should you do the same?)
- Encourage learners to see how even effective processes can result in poor outcomes
- Limit the focus of the debrief to just learning objectives to avoid talking about too many issues
- Focus on process, not outcomes

Principle 6. The provision of negative and/or normative feedback should be minimized to trainees learning a complex task.
Negative feedback (i.e., learners are failing to meet learning objectives) and normative feedback (i.e., comparing learners to an external standard) tends to shift trainees' attributions towards the self & ego protection, which generally interferes with the acquisition of KSAs. Negative feedback--especially when learning a complex task--is demotivating and tends to decrease self-efficacy. In general, positive performance feedback tends to improve self-efficacy, though it must be accurate and credible to prevent complacency and/or disengagement. Similar recommendations are noted in TeamSTEPPS training documents, where it states feedback should be timely, respectful (focusing on behaviors, not personal attributes), specific (directed toward future improvement), and considerate.
Simulation Recommendations:
- Provide a supportive climate that allows participants to share opinions openly and honestly
- Critical step, as learners cite a fear of educator and peer judgment as barrier
- Use "good judgment" framework or advocacy/inquiry to discuss negative performance and uncover learner mental models and frames that are supporting suboptimal performance

Principle 7. Guidance that directs trainees to consider what they should think about and how to think about it should be provided to trainees in learner control environments.
Guidance is a proactive "feed-forward" mechanism that encourages learners to take an active role in considering how and why they are engaging in particular learning behaviors. Guidance promotes learning through both increased metacognition (i.e., "thinking about thinking") and encouraging an exploratory/future-focused perspective on learning--both of which are critical conditions for learning complex tasks and strategies. There are many options for what type of guidance can be provided, but typical categories include focusing trainees on how and where to direct attention during training (cognition), manage effort and emotions (affect), and sequence actions (behaviors).

Simulation Recommendation:

- Learners should be encouraged to identify their strengths and weaknesses. With instructor input, this information should be used to guide training content and emphasis. In this way, learners can focus on more basic skills where they need development and challenge themselves in areas where they excel.
- Guidance can also come in the form of affect/error regulation that emphasizes to learners that good processes don't always result in good outcomes.

Principle 8. Match the level of feedback provided to the level of the goals in training.

Feedback provided in training directs individuals to allocate resources and perform self-regulation activities in relation to specific goals. However, trainees can have goals across multiple levels thereby complicating trainees' decisions about which goals to strive toward. Therefore, if the focus of training is to achieve individual-level goals, feedback providers should provide individual-level feedback so resources are directed to individual goal attainment. Similarly, if trainees should focus on team-level goals, feedback providers should provide team-level feedback to direct resources toward team goal attainment.

Simulation Recommendations:

- The debriefing plan should be pre-planned and should target appropriate level(s) based upon learning objectives.
- When individual feedback is necessary within a team context, the learner should be approached separately if there is an issue with individual clinical competence or procedural skills.
- If individual feedback on a team skill is necessary, feedback should be framed as a team-based learning point.

Attachment 4. Variables identified for use in BBN Predictive Model

	Behavioral Type	Team Clinical Behavior or Process
Intubation	Information Gathering	Assessed pupil reactivity
		Checks presence of gag reflex
		Attempts to elicit speech
		Elicit speech physical
	Communication	Communicates information about signs of head trauma
		Calculates patient’s Glasgow coma scale
		Communicates patient’s Glasgow coma scale
		Makes decision to intubate patient
		Obtains fingerstick glucose
	Action	Discusses which intubation medications to use
		Discusses dosage of medications
		Gives 1 sedation medication
		Appropriately pretreatments patient
		If paralytic used, choice and dose correct
		Orders proper sequence of drugs for rapid sequence intubation
		Stabilizes neck by holding cervical spine immobilization
		Preoxygenates patient
		Team members follow rapid sequence intubation order
		“Bags” patient following intubated
		Total duration of intubation
	Monitoring	Monitors and communicates blood pressure during intubation
		Monitors and communicates heart rate during intubation
		Monitors and communicates pulse oxygen during intubation
	Information Gathering	Verifies endotracheal tube placement
		Auscultates chest
		Checks CO_2 monitor
		Evaluates oxygen saturation after intubation
		Checks blood pressure after intubation
		Orders post intubation X ray
		Interprets post intubation X ray
		Calls radiologist for X ray clarification
		Communicates information about incorrect ETT placement
	Decision	Makes decision to adjust ETT based on X ray results
	Action	Correctly repositions ETT
		Orders repeat CXR
Circulation	Information Gathering	Requests initial vital signs
		Confirms IV line is in place
		Orders cardiac monitoring
		Undresses patient
		Request new/updated vitals
		Assesses chest wall
		Assesses abdominal area
		Checks pulse on arm/neck
		Assesses back
	Communication	Communicates prehospital vital signs
		Communicates updated vital signs
		Communicates reason for admission
		Communicates cardiac rhythm
		Orders IV fluids
		Orders second IV
	Information Gathering	Verifies IV fluids administration
		Monitors and communicates blood pressure
		Monitors and communicates heart rate
		Rhythm assessed to be “tachycardic”
	Communication	Uses word "shock"
		Discusses causes of hypertension

	Behavioral Type	Team Clinical Behavior or Process
	Action	Orders coagulation studies
		Orders type and cross match
		Orders blood transfusion
		Orders uncross-matched pprbc
		Transfuses a minimum of 2 units of uncross-matched pprbc
		Obtains a surgical consult
	Information Gathering	Assesses if blood is ready for transfusion
		Monitor vitals during transfusion
Femur	Information Gathering	Checks pulse feet
	Communication	Communicates absent right dorsalis pedis pulse
		Communicates presence of femur abrasion
	Action	Orders femur X-ray
		Orders pelvis X-ray
		Orders head CT
		Orders CT of cervical spine
		Obtains FAST exam
	Communication	Communicates finding of displaced femur fracture
		Communicates finding of widened symphysis pubis on x-ray
	Action	Applies traction to right leg
		Time to placement of traction
		Maintains traction
		Checks right dorsalis pulse after traction
		Consults orthopedic surgeon
		Places pelvis binding

pprbc = prepacked red blood cells
FAST = focused assessment with sonography for trauma
CT = computed tomography
ETT = endotracheal tube

Attachment 5. LGrubish CV

Biographical Sketch

NAME CAPT. LINDSAY GRUBISH, DO	POSITION TITLE PROFESSOR OF MEDICINE

EDUCATION/TRAINING

INSTITUTION AND LOCATION	DEGREE (IF APPLICABLE)	YEAR(S)	FIELD OF STUDY
Lehigh University, Bethlehem, PA	BS	2007	Bioengineering
Philadelphia College of Osteopathic Medicine, Philadelphia, PA	DO	2012	Medicine
National Capital Consortium, Bethesda, MD	N/A	2013	Transitional Year Internship
Resident, Madigan Army Medical Center, Tacoma, WA	N/A	2016	Emergency medicine
Chief Resident, Madigan Army Medical Center, Tacoma, WA		2015 – 2016	Emergency medicine

RESEARCH AND PROFESSIONAL EXPERIENCE:

A. Positions and Honors

Positions

2016 - present	Staff physician, Department of Emergency Medicine, Madigan Army Medical Center

Other Experience and Professional Memberships

2013 – present	Member, American College of Emergency Physicians
2013 – present	Member, Society for Academic Emergency Physicians
2016	National Resident Representative, Government Service Chapter, American College of Emergency Physicians
2016 – present	Fellow, Government Services Chapter, American College of Emergency Physicians
2014 - present	Institutional Review Board, Madigan Army Medical Center, Tacoma, WA

Honors

2007	American Society of Military Engineers Award, Lehigh University
2007	Col. Edward W. Rosenbaum Award, Lehigh University
2007	John S. Steckbeck Memorial Award, Lehigh University
2007	Joseph P. Hendrzak Memorial Award, Lehigh University
2016	Morris Award, Department of Emergency Medicine, Madigan Army Medical Center
2016	Scholarly Activities Awards, Department of Emergency Medicine, Madigan Army Medical Center

RESEARCH AND PROFESSIONAL EXPERIENCE (CONTINUED).

B. Publications

1. Tomich, Allison, **Grubish, L.** "Immunocompetent, Immunized Male With Mumps, Complicated by Orchitis and Meningitis." Military medicine 180.10 (2015): e1121-e1122.
2. Gatewood, M. O., **Grubish, L.**, Busey, J. M., Shuman, W. P., & Strote, J. (2015). The use of model-based iterative reconstruction to decrease ED radiation exposure. The American journal of emergency medicine, 33(4), 559-562.
3. **Grubish, L.**, Litner, J., & Moore, G. (2014), Recent Malpractice Cases: Beware of Syncope and Stroke!. ED Legal Letter, 2014-08
4. Tarney, C. M., Whitecar, P., Sewell, M., **Grubish, L.**, & Hope, E. (2013). Rupture of an unscarred uterus in a quadruplet pregnancy. Obstetrics & Gynecology, 121, 483-485.

C. Oral Presentations at National and International Meetings

1. Kessler, J., McGrane, K., Bothwell, J., **Grubish, L.,** *Implementation of Tactical Breathing During Simulated Stressful Situations and Effects on Clinical Performance,* Military Health System Research Symposium, 2016, Orlando, FL.
2. Koo, A., Walsh, R., Bothwell, J., McGrane, K., Knutson, T., Young, S., **Grubish, L.,** *Comparison of Intubation using Personal Protective Equipment and Standard Uniform in a Simulated Cadaveric Model Comparison of Intubation using Personal Protective Equipment and Standard Uniform in a Simulated Cadaveric Model,* Military Health System Research Symposium, 2016, Orlando, FL.
3. **Grubish, L.** *The use of model-based iterative reconstruction to decrease ED radiation exposure.* Scientific Assembly of American College of Emergency Physicians, 2014, Chicago, IL.
4. **Grubish, L.** *Comparison of Intubation Performance by Emergency Medicine Residents Using Video Laryngoscopy versus Direct Laryngoscopy in a Simulated Angioedema Cadaveric Model.* Scientific Assembly of American College of Emergency Physicians, 2015, Boston, MA.

Attachment 6. MVrablik CV

Marie Clougherty Vrablik, MD, MCR
Curriculum Vitae

mavrab@uw.edu

Education

6/2001-5/2005	Bachelor of Science, cum laude, Biology, University of Utah, Salt Lake City, UT
8/2005-5/2009	Doctor of Medicine, Saint Louis University School of Medicine, St. Louis, MO
8/2012-present	Masters of Science, Clinical Research, Indiana University School of Medicine, Indianapolis, IN

Postgraduate Training

7/2009-6/2012	Emergency Medicine Residency, Indiana University School of Medicine, Indianapolis, IN
6/2011-7/2012	Chief Resident, Indiana University, Indianapolis, IN
7/2012	Systems Engineering Initiative for Patient Safety, Short Course, University of Wisconsin – Madison, Madison, WI

Faculty Positions

7/2012-7/2014	Assistant Professor of Clinical Emergency Medicine, Indiana University School of Medicine, Indianapolis, IN
7/2014-present	Acting Instructor, Division of Emergency Medicine, University of Washington School of Medicine, Seattle, WA

Hospital Positions

7/2012-7/2014	Attending Physician, Emergency Medicine *Indiana University Health* *Methodist Hospital* *University Hospital*
7/2014-present	Attending Physician, Emergency Medicine, University of Washington Medical Center, Seattle, WA
7/2014-present	Attending Physician, Emergency Medicine, Harborview Medical Center, Seattle, WA

Honors

5/2001	National Merit Finalist, University of Utah
8/2001-5/2005	Presidential Scholar, University of Utah
7/2006-5/2009	Gardner Scholarship, Saint Louis University School of Medicine
7/2007-5/2009	Jacobs Scholarship, Saint Louis University School of Medicine
7/2008	Arnold Gold Humanism in Medicine Award, Saint Louis University School of Medicine
2/2012	Red Shoes Award, Riley Hospital for Children, Indiana University, Department of Pediatrics
3/2012	Best Poster Presentation in Senior Academic Faculty Category, Council of Emergency Medicine Residency Directors Annual Meeting
6/2012	Resident Teacher of the Year, Indiana University, Department of Emergency Medicine
10/2012	Honorable Mention Award, Quality Improvement and Patient Safety Section, American College of Emergency Physicians Annual Meeting
6/2013	Faculty Impact Award, Indiana University, Department of Emergency Medicine
2015	PRAISE Award, Harborview Medical Center
6/2016	Outstanding Educator Award Nominee, University of Washington Division of Emergency Medicine

Board Certification

6/2013, 2023	Diplomate, American Board of Emergency Medicine (ABEM)

Current Licenses to Practice

10/2011-6/2014	Indiana State Medical License
3/2014-present	Washington State Medical License

Professional Organizations

2009-2015	Member, American Academy of Emergency Medicine
2009-2015	Member, American College of Emergency Physicians
2009-present	Member, Society of Academic Emergency Medicine

Teaching Responsibilities

1/2010	Lecturer, Mini-Lessons in Patient Safety: Communication Failures, Department of Emergency Medicine, Indiana University
5/2010	Lecturer, Mini-Lessons in Patient Safety: Cognitive Forcing Strategies, Department of Emergency Medicine, Indiana University

6, 10/2010, 5/2011	Instructor, MS4 Suture Lab, Department of Emergency Medicine, Indiana University
1/2011, 4/2011	Instructor, Simulation Training, Department of Emergency Medicine, Indiana University
4/2011	Lecturer, Mini-Lessons in Patient Safety: Introduction to the Near Miss Blitz, Department of Emergency Medicine, Indiana University
5/2011	Lecturer, Approach to Head Injuries, Indianapolis Emergency Medical Services
6/2011	Lecturer, Approach to Sepsis, Indianapolis Emergency Medical Services
6/2011	Lecturer, Acute Upper Airway Disorders and Obstruction: EM Grand Rounds, Department of Emergency Medicine, Indiana University
8/2011	Lecturer, On Beyond Zebra: EM/Peds Combined Grand Rounds, Combined Departments of Emergency Medicine and Pediatrics, Indiana University
8/2011	Lecturer, The Violent Patient, Department of Emergency Medicine, Indiana University
3/2012	Lecturer, Updates to ACLS 2012: EM Grand Rounds, Department of Emergency Medicine, Indiana University
3/2012	Lecturer, Hypothermia, Indianapolis Emergency Medical Services
5/2012	Presenter, The Near Miss Blitz, Indiana American College of Emergency Physicians Annual Meeting
6/2012	Presenter, Patient Safety and Graduate Medical Education, Graduate Medical Education Committee Meeting, Indiana University
7/2012	Panelist, Expert panel, RN-Physician Communication, Department of Emergency Medicine, Indiana University
9/2012, 5/2013	Instructor, Pediatric Emergency Simulation session, Combined Departments of Emergency Medicine and Pediatrics, Indiana University
1, 5, 11/2012	Instructor, Simulation Training, Department of Emergency Medicine, Indiana University
2/2013, 2/2014	Course Facilitator, Evidence Based Medicine, Indiana University School of Medicine
3/2013	Lecturer, Nurse-Physician Communication: EM Grand Rounds, Department of Emergency Medicine, Indiana University
4/2013, 8/2013	Lecturer, Approach to the Febrile Child, Department of Emergency Medicine, Indiana University

7/2013	Lecturer, Cognitive Error and ED Providers: The Emergency Department as the Perfect Storm for Medical Error, Intern Orientation, Department of Emergency Medicine, Indiana University
9/2013	Lecturer, Research Bootcamp for Junior Faculty: Building a Database, Department of Emergency Medicine, Indiana University
6/2013, 11/2013	Instructor, Simulation Training, Department of Emergency Medicine, Indiana University
1/2014	Instructor, Simulation Training, Department of Emergency Medicine, Indiana University
2/2013, 2/2014	Course Facilitator, Evidence Based Medicine, Indiana University School of Medicine
10/23/2014	Lecturer, A Motley Crew: Collagen Vascular Diseases and Acute Immunologic Disorders, Emergency Medicine Grand Rounds, University of Washington
5/2015	Instructor, ISIS Capstone: Team Based Interprofessional Training Simulation, University of Washington School of Medicine
10/2015	Instructor, Mock Oral Boards, Emergency Medicine Residency Program, University of Washington
10/2014, 5/2015	Instructor, Medical Student Simulations: Dyspnea, Chest pain, ACLS
11/2015	Airway, University of Washington School of Medicine
10/2015	Instructor, Resuscitation Capstone Course, Emergency Medicine Residency Program, University of Washington
7/2015-6/2018	Co-Mentor and Lecturer, Continuous Quality Initiative project, Class of 2018, Emergency Medicine Residency Program, University of Washington
1/7/2016	Lecturer, Understanding Prognosis, Evidence Based Medicine Series, Emergency Medicine Residency Program, University of Washington
9/2016	Co-lecturer, Evidence Based Medicine Core Faculty group, Clinical Decision Rules, Emergency Medicine Residency Program, University of Washington

Editorial Responsibilities

None

Special National Responsibilities

3/2012-3/2013	Chair, Resident and Student Advisory Committee, Society of Academic Emergency Medicine

Special Local Responsibilities

6/2010-6/2011	Chair, Patient Safety Committee, Department of Emergency Medicine, Indiana University
6/2010-6/2011	Member, Orientation and Recruitment Committee, Department of Emergency Medicine, Indiana University
6/2010-6/2011	Member, Medical Student Committee, Department of Emergency Medicine, Indiana University
10/2010	Mentor, pre-medical interest group, Butler University, Indianapolis, IN
10/2010-10/2011	Member, 35th Anniversary Gala Planning Committee, Department of Emergency Medicine, Indiana University
1-6/2011	Chair, Senior Banquet Committee, Department of Emergency Medicine, Indiana University
4/2012	Supervising Physician, Student Outreach Community Clinic, Indiana University School of Medicine
6/2012-5/2014	Mentor, Dual Medical Marriages, Department of Emergency Medicine, Indiana University
6/2012-5/2014	Mentor, Women in Emergency Medicine, Department of Emergency Medicine, Indiana University
7/2012-5/2014	Chair, Resident/Fellow Patient Safety Council Planning Group for the Graduate Medical Education Office, Indiana University School of Medicine
7/2012-5/2014	Advisor, medical student career advising, Indiana University School of Medicine
9/2014-present	Member, Emergency Department Quality Assurance Committee, Harborview Medical Center
9/2014-present	Member, Emergency Department Safety Committee, Harborview Medical Center
4/2015-present	Member, Emergency Medicine Operations and Policy Research Workgroup, University of Washington Emergency Medicine
4/2015-present	Member, Evidence Based Emergency Medicine Faculty Core, University of Washington Emergency Medicine
9/2015	Advisor, Career Night, Emergency Medicine Residency Program, University of Washington
7/2016-present	Advisor, Women in Emergency Medicine, Emergency Medicine Residency Program, University of Washington

Research Funding

7/2016 – 3/2018 Washington State Labor and Industries Department, Safety and Health Investments Projects (SHIP) Award, *Preventing Violence against Emergency Department Healthcare Workers: A Prospective Needs Assessment to Inform Effective Intervention*
$200,000

1/2017 – 1/2018 University of Washington, Department of Internal Medicine, Patient Safety Acclerator Grant Award, *Piloting a Mobile Application for Wound Care Follow Up in the Emergency Department*
$20,000

Bibliography

Publications in Refereed Journals

1. Griffey RT, Schneider RM, Adler LM, Capp R, Carpenter CR, Farmer BM, Groner KY, Hodkins S, McCammon CA, Powell JT, Sather JE, Schuur JD, Shapiro MJ, Sharp BR, Venkatesh AK, **Vrablik MC**, Wiler JL. Development of an Emergency Department Trigger Tool Using a Systematic Search and Modified Delphi Process. *J Patient Saf.* 2016 Jun, epub ahead of print. [Original Work]
2. Schrepel C, Condino A, Linnau K, **Vrablik MC**. An Incidentally Discovered Toxic Exposure. *Annals of Emergency Medicine*, accepted for publication March 2016. Manuscript number 2016-392R1. [Case Report]
3. Mathews J, **Vrablik MC**, Paniagua MA. Plombage Migration Outside the Thoracic Cavity: A Complication of Tuberculosis Treatment. *J Am Med Dir Assoc*. 2009 Feb; 10(2):138-40. [Case Report]
4. Humphreys GB, Jud MC, Monroe KM, Kimball SS, Higley M, Shipley D, **Vrablik MC**, Bates KL, Letsou A. Mummy, A UDP-N-acetylglucosamine pyrophosphorylase, modulates DPP signaling in the embryonic epidermis of Drosophila. *Dev Biol*. 2013 Sep 15; 381(2):434-45. [Original Work]

Book Chapters

1. **Vrablik MC**, Nanagas K. Caustics. In Kazzi and Shih et al (eds), *The AAEM/RSA Toxicology Handbook*, Second Edition. United Press; 2011.

Published Books, Videos, Software, etc.

None

Other Publications

None

Manuscripts Submitted

1. **Vrablik MC**, Owens EM, Chisholm CD, Heniff ME. Error Identifying and Reporting in an Academic Emergency Department: A Near Miss Blitz. Submitted, *Annals of Emergency Medicine.* May 2012.

Abstracts

1. Owens EM, **Vrablik MC**, Chisholm CD, Heniff ME. Patient Safety Committee Impacts Resident Education. Poster presentation, Accreditation Council for Graduate Medical Education Annual Educational Conference, February 2012*.
2. **Vrablik MC**, Whitehead AC, Humphreys DE, Rhea RA, Kline JA. Clinical Factors Associated With Mortality After Intracranial Hemorrhage**.** Oral presentation, Society for Academic Emergency Medicine, May 2014*.
3. **Vrablik MC**, Whitehead AC, Humphreys DE, Kline JA. Before the Bleed: Identifying High Risk Patients for Spontaneous Intracranial Hemorrhage. Poster presentation, Society for Academic Emergency Medicine, May 2014*.

Lectures and Presentations

1. 5/2013**.** How to Become a Trailblazer: Perspectives of Resident Innovators. Society for Academic Emergency Medicine Annual Meeting.
2. 2, 5/2014**.** A CLER Plan: Implementing a Patient Safety Council for Residents and Fellows. Accreditation Council for Graduate Medical Education Annual Educational Conference, February 2014; Society for Academic Emergency Medicine, Annual Meeting, May 2014.
3. 3/2015. Resident Led Patient Safety, Council of Emergency Medicine Residency Directors Academic Assembly
4. 1/2016. Seeing Red: Navigating the Combative Patient. An Innovative De-escalation Curriculum for the Provider, International Meeting for Simulation in Healthcare.

Other Service

2-5/2010	Member, Indianapolis Bike Safety Fair for Kids Planning Committee, Indianapolis, IN
11/2011	Mentor, Photovoices Project, Indianapolis, IN ● *Mentored at-risk children and assisted them in expression and communication via photography.*
2-4/2012	Mentor, Team Triathlon, Indianapolis, IN ● *Coached and mentored 9 inner-city children in training for and completing a kids' triathlon.*
4/2012	Volunteer, Indy Connects physician, Indianapolis, IN ● *Provided free medical care for the homeless during community fair.*

Attachment 7. QUAD Chart

Development of an Integrated Team Training Design and Assessment Architecture to Support Adaptability in Healthcare Teams

MSIS-Team Performance Training Research Initiative

PI: R. Fernandez / J. Grand **Org:** University of Washington **PY2 Annual Report**

DMRDP

Problem, Rationale, and Military Relevance

- **Problem:** Conceptual models and assessment approaches to support effective team training that maximizes team adaptability and performance do not exist.
- **Rationale:** An integrated team training model will identify ***which*** individual, team, and training design factors can be manipulated to maximize team training effectiveness and impact on patient safety outcomes. Additionally, a predictive model of team performance will demonstrate ***how*** team behaviors predict future team performance and patient care outcomes.
- **Military Relevance:** This proposal directly addresses the TPT research initiative by providing a detailed framework and predictive assessment system to support team performance training to improve teamwork behaviors and patient outcomes.

Conceptual Model of Team Training Elements + **Predictive Model of Team Performance**

OPTIMIZED TRAINING

IMPROVED ADAPTABILITY AND PATIENT SAFETY

Proposed Solution

- **Objective:** To develop a simulation design architecture and predictive model of trauma team performance to support team training and team effectiveness.
- **Summary of Aims:** Integrate individual- and team-level team performance frameworks to develop a simulation design architecture and a predictive model of trauma team performance to support effective team training with automated individual and team feedback and performance assessment.
- **Outcomes:** (1) A detailed framework of the individual, team, and training design factors related to effective team performance training and (2) A predictive model of team performance that identifies how teams can adapt their behaviors to maximize their teamwork and minimize errors

Timeline and Cost (Expenditures to Date = $450K)

	Activities FY	15	16	NCE
X	Integrate individual-level and team-level simulation design frameworks to develop a simulation design architecture (Aim 1)			
X	Develop a predictive model of trauma team performance and outcomes using Bayesian Belief Networks (Aim 2)			
	Prospectively test and refine the model of trauma team performance on simulated trauma team resuscitations (Aim 2)			
	Data analysis and dissemination			
	Estimated Budget ($K)	591	556	
	Actual Expenditures ($K)	170	384	594